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THE JOHNS HOPKINS UNIVERSITY

Editor—HENRY E. SIGERIST

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CONTENTS

Old Hopkins Pictures No. 8: Dr. William Sidney Thayer in 1897, during his Period as Resident in Medicine at the Johns Hopkins Hospital ..... Frontispiece

Medical Ethics: A Lecture to the Fourth Year Class of the Johns Hopkins Medical School: WILLIAM S. THAYER 613

Greek Medicine and its Relation to Greek Civilization: JOHN RATHBONE OLIVER 623

TEXTS AND DOCUMENTS

A Student's Exhibit Illustrating the History of Physiology 639

MEDICO-HISTORICAL ACTIVITIES IN THE UNITED STATES

Baltimore, Maryland 697

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DR. WILLIAM SYDNEY THAYER IN 1897, DURING HIS PERIOD AS RESIDENT IN MEDICINE AT THE JOHNS HOPKINS HOSPITAL

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MEDICAL ETHICS

A LECTURE TO THE FOURTH YEAR CLASS OF THE JOHNS HOPKINS MEDICAL SCHOOL

W. S. THAYER

May 27, 1929

(Taken by C. Hanley, with additions by Acton.)

The last thing I spoke to you about was telling the truth and the necessity of stressing this point. It rarely pays to lie, as we have all found out. We should endeavor to find out what the patient wants to know, find out how much he wants to know, and tell him the truth. Then direct him toward hope—which is a necessary thing for all of us. You will find that practicing medicine in the public mind is mixed up with mystery, and we all are supposed to be led by something mysterious, which of course we aren't at all. . . .

Another thing that is really of the utmost importance, and really the duty of practitioners, is optimism. You really must be optimistic with your patients. You must find out every time whenever you can give a good prognosis. Whenever there is a loop-hole for it, encourage the patient. That is the greatest hope that age brings to practitioners. When you have lived long enough you will make enough mistakes to put an amendment to most prognoses. You will have seen patients whom you thought could not possibly get well, recover, and you will have seen mistakes made over and over again. When

you begin, your knowledge is largely from the limited experience of the hospital and wards.

In 1899 one of my relatives brought to me a dear friend of his who had had at one time a slight apex tuberculosis from which she entirely recovered. She had an exacerbation and was sent to Saranac. She did very well until all of a sudden she had hematuria and in the urine tubercle bacilli were found. She came down here, was examined by Dr. Kelly and the affected kidney was removed in the spring of 1900. She was perfectly well until six years later when, under great mental stress, she went down hill again, bilateral tuberculosis started up, abscesses, she had tuberculous pleurisy on the right side, a tuberculous peritonitis, appendicitis which turned out to be tuberculous, pus re-appeared in the urine and I had her admitted to the hospital in the fall of 1905 or 1906, with a temperature going every day to 104°. Dr. Trudeau, who happened to be in town, dropped in to see her one day and said the poor girl probably won't live more than two weeks. That was in the fall of 1906, and by the following June she was out of the hospital symptomatically well. She has been earning her living ever since. Now there wasn't even one chance in a million for that girl. When you see a few things like that you feel you have a right to encourage patients. One must always look up and not carry a long face. Certain people nevertheless cannot seem to help being scared and worried about things, and give themselves away. I remember another man whom I looked after in his last illness who told me in great secret what he had never told anyone before: that he had a systolic murmur. I told him once or twice during the examination that I found the heart of normal size and finally that there was no cardiac disease whatever. When I told him he looked up and I shall never forget the expression on his face as he said: "I have been a damn fool for thirty years." . . .

The thing to do in talking to patients about things is to tell them the truth and then emphasize the possibility of things being better. We are dealing almost entirely with possibilities, and it doesn't do any harm to encourage them. You will find that what you say to patients is rarely quoted correctly anyway.

One of the first experiences I had along this line was with a patient of Dr. Osler's on the private wards, who came here from the

Eastern Shore. The things he said during the examination and about his previous treatment made his doctor out to be a most abominable fellow. Four or five years later at a meeting of the Seaboard Medical Society in North Carolina, I met his doctor and soon I was asked if I remembered this patient. I almost shivered. The doctor then proceeded to tell me all about him. He had sent him up here for a perfectly good and sufficient reason, and he had accomplished just what he had sent him up for. When the patient had returned he continued under his care as before. So when a patient tells you something queer about another doctor, nine times out of ten you will find that the doctor is perfectly all right.

Another thing is to be taciturn. Do not say too much. I had a patient come to see me. He was overworked, probably 65 years of age, had a letter from his doctor and wanted to come into the hospital. I sent him to a G. U. man who found some urinary obstruction for which he was treated and sent back home. A year later he came again. His doctor in a private letter to me suspected cancer. I examined the prostate, found it very hard and nodular, in fact so hard and nodular that I rather suspected it was carcinoma. I sent him back to the same G. U. man who found very marked hypertrophy, not carcinoma at all. I blush to tell the tale, that in talking to that man afterwards, I admitted that I had had some ideas that it might be malignant and I was delighted that it was not, and that the operation was not such a serious matter. But do you think he heard what I said? Not a bit of it! The word cancer scared him so he went around telling all his friends I'd said he had cancer. It was all perfectly unnecessary and I did the very thing that I preach against: Keep from saying too much.

There is a story that I recall in connection with that—a remark by Sir William Stokes. A friend sent his son for some advice before going into the practice of medicine. The son came to call on Sir William, and they talked pleasantly about various things—except the practice of medicine, and when he was standing at the door to say goodbye, he said: "Charlie, don't say too much." And with this advice, the son went out. When he had reached the gate not far away, the old man called him back and put his arm around him and said: "I'm very fond of you, Charlie, don't do too much."

. . . But don't say too much. We should always watch carefully what we say to patients. Be very careful not to put wrong ideas into their heads.

A doctor cannot practice politics. This is done in some of the Continental countries, particularly France. There some of the most noted politicians are doctors, Clemenceau. . . . This is found to a less extent in some other countries. . . .

Of course we suffer a little from being governed entirely by lawyers. A lawyer analyzes accomplished facts and looks for the reasons why something has gone wrong. A lawyer is rarely very constructive. His criticism is apt to be the destructive criticism of all who demand that in truth there will be no failure. They are very apt to fail to see that life itself is often a failure, and a physician, dealing with what he does is dealing entirely in the future. Nothing can be absolutely certain.

The same thing is true of religion. Medical missionaries have often done a great deal of good, but it is the medical and not the religious activities. The doctor who devotes too much of his time to religious activities gets into trouble, and if you are practicing medicine make whatever else you do an avocation, don't have a divided vocation.

Another matter that I think is extremely important in practice is for physicians to join the City Medical Society and go to the meetings. Of particular importance is our attitude in regard to matters of public health. The position of Director of Public Health should be given to a man especially trained in matters of public health. In many communities the Director of Public Health is a position given by the Mayor or some politician to some deserving family practitioner who has reached the age when he can no longer carry on an active practice. This is all wrong and as practitioners you should use your influence to prevent that sort of thing from going on.

The next point is the importance of playing one's part with public health officers. This is sometimes an awful bore, but the physician has got to play his part and feel it is his duty to cooperate with the health authorities no matter who they are or how poor they may be. There is a good story which Charlie Mayo told me himself. There

was such a condition in Rochester, Minnesota, and it was impossible to make the city officials pay any attention to the objections that were being raised. Finally, Dr. Mayo wrote to them about it and said if they didn't do something about it he would take it up with the State committee; whereupon a group came to his office and said they had got his letter and made him Health Commissioner. He immediately hired a trained sanitarian to direct the work, for he knew he had neither the time nor the training to give to it. He had a large pig farm, and arranged to dispose of all the city offal to feed his pigs. He made a great success of the farm and made enough on it to pay the health officer's salary. At the end of a number of years, the city being in good condition, he came to the Council and told them that if they would agree to keep the suitable health officer, he would present his pig farm to the city. And he did.

Another thing in regard to your relation to the public is the question of your relation to the press. It is a difficult matter—this old question of advertising. There is no reason why good doctors should not advertise. The only objection is that it does not pay. It eventually does more harm than good, for the moment you advertise, you put yourself in competition with others who can outdo you every time. Then there is the institute with entirely altruistic designs which arranges for the examination of patients at moderate rates and encourages yearly examinations. This is a good plan, very good indeed, and very decent in many ways, but these institutions have turned to advertising. Immediately the temptation comes, when doctors find patients going there, to form their own groups and advertise. Quacks can do the same thing, giving rise to trouble, confusion, and mix-ups generally. Then again the question has been brought up very largely in regard to hospitals. Hospitals operate diagnostic clinics to reduce the rates for doctors who want to bring patients who cannot afford to have the examinations done in private offices. Then again you see advertised this, that, or the other dispensary. A group of doctors see the X Hospital Dispensary properly advertised, and wonder why cannot they gather a group of men together and advertise in the same way. Then we get a group of quacks who do the same thing and call it a diagnostic clinic. Just

about 99 of a hundred diagnostic clinics are not very good places for just that reason. This is because of the fact that a group of doctors get together in all the different branches, and if you are to see a specialist, you must see their specialist. You will soon find when you get out in practice you don't always want the same surgeon or the same nose and throat man for all of your patients. On the contrary you have to choose the surgeon or the nose and throat man or whomever you want to consult for each particular patient. You have to suit the patient.

I got off my subject a little bit. I was talking about advertising. You run against quacks who advertise and the patient cannot make out what it is all about. In the long run advertising does mislead people, and it has been found out by long experience that it is the wrong thing to do. That is really the whole story about advertising. Reporters are always about. . . . In dealing with the press you have got to remember that reporters are paid to go out and get news and often they are paid according to the news they get. They will come around asking perfectly impossible questions, and it doesn't do any good to be nasty to them. Dodge them if you can, but if you can't, treat them like human beings. I have never had but one reporter break trust with me, just one. And I am sorry to say, he was a second or third year medical student. The only other thing I can say is that he ended up in Atlanta in the United States Jail there afterwards. He was just crooked all the way through. It is always possible to explain to reporters when they ask about patients, that it is not possible to tell them. I remember a question in point in California a few years ago. A reporter came to ask me about a very explosive question and, of course, I couldn't tell him anything. (Something here about the fact that the initial furor was not so bothering as the eternal keeping up of the discussion it would involve). I had just written out my feeling about that point and I told him I had written my opinion about it in plain words a few days ago, and that I had the paper upstairs. It is a perfect nuisance for me to talk on a subject of that sort. I have very strong feelings about it, but object to keeping up a discussion. I let him see what I had written and told him that I couldn't possibly have him use my

name. He said "Doctor, that is enough." It was enough. . . . If you like to appear in the newspapers, you can do so. . . . You always find out what happens.

Now one other thing that is very important is the question of charges. Don't overcharge a man because he is well-to-do. That is the tendency and doctors are pretty generally suspected now of trying to do that, and there are all kinds of books that jest about it, and one hears all sorts of things. The practice of medicine is a serious thing and doctors should not sit around and take part in conversations when all sorts of slighting things are said about doctors and medical practice without doing anything about it. You wouldn't let anyone talk about your mother, and the true physician should really not allow that sort of thing to happen to his profession. He should get out or move on whenever anything of that sort starts, whether about medicine or about physicians. Don't let them ever say mean words in your presence. A man, when he starts practicing, usually charges what is customary in the community in which he starts. I have always felt that a man should have a perfectly clear idea what he should charge for giving the sort of service that he gives. He should have a regular maximum charge for a given sort of service. He should never go higher. When he has someone who demands twice as much time, well and good, but don't raise your charges just because a man happens to be well-to-do, but it is the rarest thing in the world for a man in practice to become rich. Of course, there are some men who are naturally financial geniuses. But you cannot ever feel you are doing your duty if you practice medicine seriously for making money. A man should know his maximum charge. That charge is going to grow as he gets busy and wants to relieve his practice. But he should know his charge and not speculate on patient's means. When Dr. Finney started in, he used to charge from $200 to $500 for an appendectomy. He was called one day to see a very wealthy patient in consultation and for the operation charged his maximum fee of $500. Three years later, the first cousin of the former patient was taken sick. The family physician tried to get Dr. Finney, but couldn't as he was out of town. So a younger man, not nearly so well known, was called in and his bill was $3,000. . . .

One of the most important things in practice is our method of dealing with our colleagues. Look through the book of ethics of the American Medical Association. There is scarcely a day that the Judicial Council of the American Medical Association is not asked for advice in regard to these emergencies. . . . Osler had a rigid rule of never saying an ill word of another physician. I remember once a friend had come down from Montreal, a doctor who used to be here. As we were at dinner, he started to tell a scandalous story of another doctor. All of us knew what was coming, but Osler turned to a statue behind him and said: "Do you see that statue of King Arthur I ran across the other day?" The man grew red as a beet and stopped. That was Osler's inflexible rule, never to let anyone speak badly of another in his presence. . . . Never let anyone say an ill word of a colleague. If you feel someone has done something not quite what it should be, go see him face to face and talk it over. That is all right. But the moment you cut him and tell someone or another that doctor so and so has done so and so, the next time you meet him you are uneasy and you cannot be quite comfortable when you shake hands with him. So long as you never SAY a mean word about another, you are all right. But the moment you begin to talk about another, it is all over, you are ill at ease, you are not quite yourself, you are conscious of doing something behind his back. That is one of the most important things in the life of a doctor. If you don't like a man, don't criticize him. That is not professional etiquette, it is just being decent. Don't repeat the things you hear about another doctor, even though they are true. The other fellow, perhaps knows a good deal more than you hear or suspect. Don't talk. Controversies arise between doctors about petty things, and there is trouble right off, the moment you allow yourself to get in the habit of talking meanly about them. Controversies are very apt to arise over the telephone. Dodge the telephone if you possibly can. Write him a letter, or see him face to face. Dobbin, he's dead now, but one of the best fellows that ever was, an obstetrician, was called up one night and asked to attend the patient of a friend who made no night calls. He went, and the next day phoned the older man what had taken place. The older man said: "Tell

him I'll forgive him this time if he will never do it again." Quite jestingly. But poor Dobbin took it to heart and there was coldness between them for a long time. When talking over the telephone, you cannot see the other man's face, and meanings are likely to be mistaken.

There are one or two specific things about when you are in practice. One is to be on good terms with your neighbor. Show him you are willing to trust him occasionally. If his patients come to your office, you cannot refuse to see them. There are occasions when your colleagues go away for vacations and if their patients try to come to you afterwards, you must use every means to tell him the situation, and if he tells you all right, well and good but if not, then you simply cannot take them. If you go to see a patient in consultation, and if when the consultation is over, the patient comes around and tells you he wants you to take the case, you simply cannot do it. You cannot afford to. Whenever those things come up it is best to see your colleague face to face, and talk over the situation. You must get into your mind that a patient does exactly as he pleases. He may consult anyone he chooses. It is up to you to try to give him the best service you can. Try to please, and if you cannot do that, shut your mouth and let him do what he wants to do. Never lose your temper with your patients. When a patient simply won't do what you want him to do, tell him plainly that you do not want to treat him further, and why. Very often under these circumstances, he will be careful of your orders. But he may not. Then the best thing is to get rid of him before he discharges you. As I said in the beginning, it is a difficult problem, but you can't lay down rules for them. They must lay down rules for themselves.

The main thing in practicing medicine is to do your duty. There is no difference, practically, from what you are doing now. You may think you are through your studies now that you are about to practice, but the moment a man ceases to be a student, the moment he puts his attitude of interest in medicine behind him, he is already old. The only difference now is that you have a little more guidance, and a little less responsibility. As an interne, you will have a little more responsibility, and as you get out you will have a little more

yet. In school you are perhaps going to class exercises upon command. In the University you go for self-education under guidance. The guidance is dropped a little after you get over your interneship. There is a little book on ethics of the American Medical Association, most of which was written by Dr. Bryant of New York and Dr. Welch in a little bedroom in New Orleans. While I slept in the bed, they sat up all night finishing that book. In it is only indicated what a man should do—do the best you can. . . .

GREEK MEDICINE AND ITS RELATION TO GREEK CIVILIZATION *

JOHN RATHBONE OLIVER

Anatole France says somewhere that "history is an art that should be practiced with imagination." In preparing this paper, I have found that an attempt to discover objective facts has proved rather futile. Nevertheless, I am unwilling to follow Anatole France's advice and to fall back entirely upon my imagination. My position is all the more difficult, because for the past fifteen years, I have consistently preached a certain medico-historical doctrine that now hampers me considerably. I once tried to show in "Medicine from the Standpoint of History" (International Clinics, Volumes II, III and IV, Series 37 and Volume I, Series 38) that the true picture of the medicine of any particular period is not to be discovered in the medical books, written by contemporary physicians, but rather in the general literature and sociological background of the age. In other words, I attempted to prove that without a first-hand knowledge of contemporary non-medical literature, no medical historian could accurately portray or understand the medical life and practice in any definite period of time. In this paper, I am asked to do exactly the opposite thing. I am asked to show, if possible, what contribution to the history of Greece can be made from the Greek medical texts that have survived. I am expected to give, so far as Greece is concerned, some rational reason for the study of what is commonly called Greek Medicine, in so far as a knowledge of it may bring to the professional historian of that civilization sidelights and suggestions that cannot be found anywhere else.

Of course, the Greek physician was an important part in the life of his country and, as such, his writings and his doings are a part of Hellenic history. Dr. Kenneth C. Bailey, Fellow of Trinity College, Dublin and President of the Dublin University Experimental Science Association, said in his Presidential Address of November 7, 1933 (Science Progress, a Quarterly Review of Scientific

* Read before the History of Science Society in Washington, D. C., on December 29, 1934.

Thought, Volume 28, No. 112, April, 1934, p. 613), "What is history, but the history of the doings of humanity? What are more intensely human than health and sickness, misery and comfort, life and death? A remedy correctly applied at the correct moment might have far more than individual results. Twenty years more of life to Alexander the Great might have changed the course of history." This, of course, is sound reasoning. Unfortunately, however, in the Greek medical writings that have survived, we do not find much reference to historic individuals or events. There are, it is true, in the Epidemics of Hippocrates, a number of case histories, but these all deal with unknown persons, whose sickness, recovery or death did not, so far as we know, influence any great historical event. Except for these case histories in the Hippocratic Corpus, we find no similar medical productions, with the exception of an occasional case history in ar-Razi, until we come to the Mediaeval Concilia. In the Greek medical texts, therefore, we cannot hope to discover any definite thing that any Greek physician did, which, so far as we know, influenced in an important way the life of any historical personality. We must approach our material on broader lines.

In the Hippocratic writings, especially in the Epidemics, one is struck by the prominence of the symptom of fever. It seems to stand in the very foremost front of the physician's diagnosis. It must, therefore, have been a very frequent reaction and this frequency explains the reason why the Greek physician divided fevers into so many types. Following the Hippocratic tradition, Galen divided fevers into chronic and into intermittent fevers. The intermittent ones were again divided into quotidiens, tertians, with a relapse every other day, and quartans, with a recurrence of fevers every third day. This whole complicated mapping-out of fevers suggests the prevalence of the symptom. Moreover, in the same Hippocratic books, another symptom appears quite frequently, namely, an enlarged spleen (e. g. Epidemics III, Case 3: Littré: iii, p. 40, l. 10 and Epidemics I, Case 1: Littré, ii, p. 684, l. 8).

In 1907, that delightful and thorough Hippocratic scholar, Dr. W. H. S. Jones of St. Catherine's College, Cambridge, noted these and similar characteristics of the Hippocratic writings and, in collaboration with Professor Major Ross of Liverpool University,

produced an epoch-making little book on malaria. (Malaria. A Neglected Factor in the History of Greece and Rome by W. H. Jones with an introduction by Major R. Ross and a concluding chapter by G. G. Ellett, M. D. Cambridge, Macmillan and Bowes, 1907.) Jones tried to show that some of the Hippocratic writings witnessed to the prevalence of malaria, or, at least, to its beginnings in the 4th or 5th Century B. C. He concluded that Greece was not highly infected during the 4th Century, but that the infection increased until it gradually undermined the physical and mental powers of the Hellenic States. Another symptom connected with malaria is the word "melancholia," which is so often associated with malaria and appears so often in the Hippocratic writings (e. g. Aphorisms, Book iv: 9, vi, 23. Littré, vol. iv, p. 504, 9: p. 568, 23).

In the best known of all the Hippocratic books (Aphorisms), the writer says that the diseases of the spleen are associated with quartan fevers (that is, malarial fever recurring every third day), and that these are very prevalent in the autumn (Aph. iii, 22. Littré, iv: p. 496, 22). Moreover, the writer of the book Περὶ παθῶν says that those who have enlarged spleens are bilious, have a muddy complexion, suffer from an evil breath and are always constipated (§ 20. Littré, vi, pp. 228-230). This is not the type of individual that we associate, or that history associates, with the victors of Marathon and Salamis.

Jones' investigations, therefore, seem to prove that the knowledge of Greek Medicine which we gain from the Hippocratic writings throws a new light on the history of Greece. Who has not wondered at the decline of Hellenic civilization? Who has not admired from the depths of his soul the heroic deeds of the Persian Wars and the liberation of the Greeks from Eastern influence? Who has not, moreover, watched the gradual disintegration of the manhood that was so dominant and victorious, watched it becoming less and less self-sufficient, until it splits up into petty jealousies and still pettier politics? If there were a real physical explanation for this, it would cast valuable light on these otherwise inexplicable phenomena. If in the 4th Century, Greece was already infected with malaria and if, little by little, malaria became endemic, we

should be able to understand what the power was that sapped the manhood of the country that had once been so glorious. We should learn then that it was not Philip of Macedon who destroyed the liberties of Greece, that the enemies of Attica were not the Lacedaemonians, but rather that the unseen, deadly enemies of the whole Hellenic civilization were the four types of malaria parasites and the armies of the poison-laden anopheles.

The interesting question as to the importance of malaria as an element in the history of nations was taken up where Dr. Jones dropped it and carried on in a much more complete manner by the late Angelo Celli, whose important book on "The History of Malaria in the Roman Campagna from Ancient Times" was edited and enlarged after his death by his wife, Signora Celli-Fraentzel. (The History of Malaria in the Roman Campagna from Ancient Times by the late Angelo Celli. Edited and enlarged by Anna Celli-Fraentzel with a preface by Sir Arthur Castellani. London, John Bale, Sons and Danielsson, 1933.)

Not a few scholars have found interesting parallels between Thucydides and the person whom they call Hippocrates. Nowadays, scholars have given up the use of the word Hippocrates, as denoting an historical person who was the author of, at least, some of the books that are contained in the Hippocratean Corpus.

The great scholar, Dr. von Wilamowitz-Möllendorff, when he was preparing his "Kleine Griechische Lesebuch," included in it two texts from the Hippocratean Corpus: the book on Ancient Medicine and the book on Airs, Waters and Places. In his introduction to these texts, he refused absolutely to connect with either book the historical personality of the physician Hippocrates. He said that Hippocrates was a "name without writings."

For generations, physicians and scholars have discussed the authenticity or the non-authenticity of various books in the Hippocratic Corpus. Even Galen has a list of those books that he considers authentic and those that he thinks were written by someone else besides the Father of Medicine. We have come to a final end of such discussions. Dr. Ludwig Edelstein (ΠΕΡΙ ΑΕΡΩΝ und die Sammlung der Hippokratischen Schriften. Problemata . . . hft. 4, Berlin, Weidman, 1931), in his important publication on the book

Airs, Waters and Places, published in 1931, has shown that no single book in the Corpus can be definitely connected with the Hippocrates, mentioned by Plato in his Phaedrus and in his Protagoras—the Hippocrates who came from the Island of Cos, who was one of the Asklepiadae, who taught medicine for a fee and who agreed with Socrates in believing that we cannot satisfactorily comprehend the nature of man apart from the nature of the universe.

Therefore, when scholars attempt to draw parallels between Thucydides and Hippocrates, they are on difficult ground. They have, however, traced definite grammatical parallels between the constructions of Thucydides and the constructions of some of the books of the Hippocratean Corpus. They have suggested, therefore, that inasmuch as the writer of some of the Hippocratic books, especially Epidemics I and III, evidently spent much of his time in Thrace, the peculiarity of his Greek is to be ascribed to the influence of a Thracian dialect: it is Thracian Greek. The next step is to proclaim that as Thucydides was closely connected with Thrace, his Greek was not good Greek, but was also influenced by Thracian dialect, which makes his constructions so unusual and so difficult. All devout Thucydideans, among them the great Dr. Basil Lanneau Gildersleeve, have arisen in their wrath and have hustled out of court this scandalous theory about the Father of History. Yet, the gossip still survives.

Dr. Abbot, however (Thucydides, A Study in Historical Reality, by G. F. Abbott. London, Rutledge, 1925), in a chapter on the style of Thucydides (pp. 223-228), also suggests that the style of this historian can be explained by the fact that Thucydides is said to have been a Thracian, that he married a Thracian heiress and that, therefore, Greek was not his native language. Dr. Abbott quotes the saying of some unknown scholar that the Greek of Thucydides is, at its best, good Thracian. If this be accepted, then the parallels between the style of Thucydides and the style of certain of the Hippocratean books may give us some suggestions about the author of those books that show parallels with Thucydides, namely, that this author had also lived in Thrace and must have been a wandering physician, like the traditional Hippocrates.

There is, however, another parallel, not grammatical, but a

parallel of historical construction. In 1929, Dr. Charles Norris Cochrane produced a very interesting study entitled, " Thucydides and the Science of History " (published by the Oxford University Press in 1929). In this study, the writer attempts to connect Thucydides indirectly with Democritus and directly with Hippocrates. As I have already said, it is difficult to know what he means by Hippocrates and to which books in the Corpus he is referring. He urges, in the first place, that the knowledge of the Hippocratean Corpus throws light on the method of Thucydides, that Thucydides must have known some of the books in the Hippocratean Corpus, because, in a much disputed passage, namely, in Bk. I, Sec. 23, Thucydides uses the Greek word " prophasis," when he is describing the grounds for the Peloponnesian War, of which the growth of Athenian power was, he says, " the most real cause." The word προφασις, Dr. Cochrane urges is a medical word and we would normally expect the Greek word αἰτία. The writer of the book on Ancient Medicine (Section 20), and the writer of the book on Airs, Waters and Places (Section 22, Littré, ii, p. 80, l. 20, C. M. G. Hip., p. 75, l. 22), uses " prophasis " in the sense of a motivating, pathological activity that is important for some definite disease. It is difficult, however, to believe that " prophasis " is entirely a medical word. Dionysius of Halicarnassus in his treatise on the history of Thucydides, although he criticizes minutely Thucydides' vocabulary and style, still finds no difficulty in the expression " prophasis." (See Abbott, op. cit., p. 58, note 1. Also pp. 19, 22 and 58.)

Dr. Cochrane also deduces from Thucydides' description of the plague in Athens the probability that he must have had some contact with medical writings and may, perhaps, have known some of the Hippocratean books. Many critics have tried to connect the constitution in Book 3 of the Epidemics (Littré, iii, pp. 67-102) with the plague year at Athens, as described by Thucydides. All these matters are merely suggestions and are not philological facts.

Dr. Cochrane's other proposition is more interesting. He traces a connection between Thucydides' conception of the writing of history and the medical study of prognosis as described in such books as Prognostic, First Prorrhetic, Coan Prenotions and other prognostic treatises of the Hippocratean Corpus. The Greek physician of

the 4th and 5th Century, as personified in Hippocrates, believed that the human body was a persisting entity, that it always reacted in the same way to the same type of environment and so from a consideration of the body symptoms and of the environment the doctor could make a definite prognosis. In the same way, the scientific historian, accepting the dictum that human nature reacts in the same way everywhere, can by assembling the facts of a certain period of human activity, and studying the environment to which it reacts, make a historical prognosis of what the historical outcome must have been. All that this would prove, if it were absolutely true, would be that the writer of certain Hippocratic books and Thucydides were children of the same age and were in touch with the same type of thought that may be traced back to the teachings of Democritus. As a matter of fact, part of the thesis of Dr. Cochrane had already been anticipated by another Thucydidean scholar, Dr. G. F. Abbott, whose book was published in 1925. All these matters are very thin threads of information and are not very satisfactory as a proof that a knowledge of Greek medical texts is of value to the historian of Greece.

In these texts, one seeks in vain for medical material that would throw new light on prominent personages in Greek History. We are not able to adopt the method of Dr. C. MacLaurin (Mere Mortals, Medical-Historical Essays, New York, G. H. Doran & Co., 1925), who places certain great historical personages, such as, Henry VIII, Queen Elizabeth, Dr. Samuel Johnson, Frederick the Great, etc., in a much more understandable light by treating them as patients and applying to them the results of our modern medical knowledge.

Henry VIII, for instance, becomes much more understandable when we know that he was a syphilitic and that his son Edward VI was a victim of delayed hereditary syphilis and pulmonary tuberculosis.

In the case of Henry IV of France, we learn to forgive much when we realize that during his old age he suffered from gout and developed a satyriasis, connected with some prostate trouble, that made him the slave of every good-looking girl and the rival of thousands of husbands. Interesting revelations of this kind cannot

be evoked from such knowledge of Greek Medicine as we derive from our Greek medical texts.

Approaching the subject on still broader lines, there can, of course, be no doubt that the medical men in Greece were always of importance and without doubt were influential in molding history in ways that are unfortunately not known to us.

We know what the social position of a physician was in the 4th and 5th Century. Nothing gives us a better picture of the physician as an esteemed guest than the Symposium of Plato, in which Eryximachus, himself the son of a physician, who has followed his father's profession and belongs to the great Guild of the Asklepiadae, plays so great a rôle. He speaks of his own medical practice, which has made it clear to him that too much wine is harmful (Section 176 D). He also mentions (177 B) having read a book on diet, in which salt is made one of the most important elements in dietetics. Finally, it is he who helps to cure Aristophanes, who has developed an attack of hiccoughs, which prevents him from speaking. Eryximachus tells him to hold his breath for a good while, or if that does not stop the hiccoughs, to gargle with water. If that fails, Aristophanes is to take something that will tickle his nostrils and make him sneeze (Section 185 D & E). You will remember that the distinguished guests in this Symposium, the poet Agathon, that spoiled darling of the gods, Aristophanes, the comedian, and later on in the party the great Alcibiades, were all amusing themselves and exercising their minds by speaking, each in his turn, about love or rather of Eros, the God of Affection. The speech of Eryximachus is the speech of a physician and of an excellent psychiatrist. He says (Section 186 B ff.). "For the art of medicine may be summarily described as a knowledge of the love-matters of the body in regard to repletion and evacuation; and the master-physician is he who can distinguish there between the nobler and baser Loves, and can effect such alteration that the one passion is replaced by the other; and he will be deemed a good practitioner who is expert in producing Love where it ought to flourish but exists not, and in removing it from where it should not be. Indeed he must be able to make friends and happy lovers of the keenest opponents in the body. Now the most contrary qualities are most hostile to each

other—cold and hot, bitter and sweet, dry and moist, and the rest of them. It was by knowing how to foster love and unanimity in these that, as our two poets here relate, and as I myself believe, our forefather Asclepius composed this science of ours. And so not merely is all medicine governed, as I propound it, through the influence of this god, but likewise athletics and agriculture." He claims, therefore, that not only medicine, but even athletics and agriculture and music are governed by the influence of Eros. In other words, he is an out-and-out Freudian.

However, the name of Eryximachus has not been for generations in the mouth of every physician. Yet, there is infinitely more about him and his ideas in Plato than there is about Hippocrates, who, as I have already said, is only mentioned casually in two dialogues. How, then, did it happen that of the physicians of Plato's time only the name of Hippocrates survived and developed an aura of fame that carried it down through the Middle Ages and triumphantly into the Renaissance? It is true that during the Middle Ages, Hippocrates became a great magician, but, then, Vergil, during the same period, became a sorcerer also. In other words, both were still names of great power. This is one of the mysteries of Greek History that may never be solved. The triumphant emergence of the one name of Hippocrates, its association with a collection of Greek medical writings—most of which could not possibly have been written by the supposititious author—and the development of this hazy personality into the clear-cut picture of the Father of Medicine is an amazing fact that most of us do not realize and none of us understand. It is easy to say, with Dr. Edelstein, that during the Alexandrian Period, Plato and Aristotle were the gods of the intellectual world and that the name of Hippocrates survived and was tacked on to all surviving medical writings of the 4th or 5th Century just because Plato had mentioned him twice and had said, in the Phaedrus, through the mouth of Socrates, that the teaching of Hippocrates agreed with his own. Why did not our Freudian friend, Eryximachus of the Symposium, survive also?

One part of Hellenic culture must have been intimately connected with medical teaching, namely, the hygiene of private life. One of the foundations of Greek health was, without doubt, the custom of

constant bathing. Professor Sudhoff has written a delightful little monograph on this subject, with illustrations from vase paintings. (Aus dem antiken Badewesen . . . Berlin, 1910. See also L'Hygiène chez les anciens Grecs par Dr. Mme. Angelique G. Panayotatau, Paris, Vigot freres, n. d.) The writer of the Hippocratic book on Regimen in Acute Diseases (Littré, ii, p. 364, § 18), insists on the beneficial use of the bath to patients who are not critically ill. His description suggests to us the permanent bath given to a disturbed patient on a psychiatric ward. The writer says that the necessary things include a covered place, free from smoke, and an abundant supply of water. The patient must be quiet and silent. He should do nothing himself, but leave the pouring on of water to others. The water should be tepid. The attendants are to use sponges, instead of scrapers and the body must be anointed, before it is quite dry. The head should be kept from extremities of cold or heat. The writer adds that if the preparation be adequate, the patient may bathe every day and those who are fond of bathing will not be harmed by even two baths. Lucian, in his Hippias (Sec 4), although he belongs to a much later date, gives us a long and complicated description of hot and cold baths, as well as of their remarkable benefits.

Diet, of course, is another element in public hygiene or health and even the most casual reader of the Hippocratic books knows how many treatises there are that deal with diet. (See especially the book Regimen in Acute Diseases.) The writer of Ancient Medicine (Section 20, Littré, i, p. 622, l. 5-14), sums it all up when he says, " This, at least, I think, a physician must know— namely, what man is in relation to food and drinks and habits in general and what will be the effects on each individual. It is not sufficient to learn simply that cheese is a bad food, as it gives a pain to the man who eats too much of it. We must know what the pain is, the reasons for it and which constituent of the man is harmfully affected." (See also—" Antike Diätetik " von Ludwig Edelstein. *In* Die Antike, vol. 17, 1931, pp. 255-277.)

The Hippocratic books, also, have some relation to gymnastics, that supremely important element in Greek life. In the book on Diet or Regime (Book II, Section 66, Littré, vi, p. 582, l. 1-9),

the writer points out that men who do not exercise regularly get tired very easily when they have to work, because no part of their bodies are accustomed to fatigue, while a body that has been well exercised and developed only feels fatigue when the work to be done is not a customary one or is a customary one pushed to excess. In another section of the same book, Section 62, the writer advises walks before breakfast, as they get rid of surplus flesh, make the brain clear, the vision acute and lead to a regular evacuation.

On the social life of Greece, however, the influence of the Greek physician was not always beneficial. At least, one might say that it would not be approved by modern society. We have much information about the doctor's office, the iatrieon. In the Hippocratic Corpus, a whole treatise is devoted to it (Littré, vol. iii, pp. 272-337). The type of room that is necessary is described, its furnishings, the way in which it must be lighted and the instruments that must be kept ready there.

There exists a small Greek perfume bottle, an aryballos, made in Athens about 400 B. C. The painting on it represents the interior of an iatreion. (E. Pottier, Une Clinique Grecque au V Siecle, Paris, 1907.) In the centre, the young physician is seated, holding a lancet in his right hand and compressing, with his left, in the arm of a patient the vein which he is about to open. Below that patient, stands a large vessel ready to receive the blood. On the walls, are several cupping instruments. On the right, are two other patients, who are seated and awaiting the doctor's attention. Beyond him, is another figure smelling a flower, perhaps, with the idea of preventing infection. On the other side, behind the physician is an old man with a bandaged leg. Next to him is a curious figure—a typical dwarf with hairy body and infibulated penis. He carries a rabbit almost as big as himself. Dr. Singer considers him a case of acondroplasia, a dwarf who was the doctor's servant.

The iatreia, of which this vase painting gives some slight suggestions, were unfortunately not always places of good repute. Just as the modern gay adolescents gather at drugstores, so the gay youth of Athens used to drop in at doctors' offices. The modern American youth is attracted to the drugstore by the possibility of a flirtation; the youth of Athens were attracted to the doctors' offices

for the same reason. But in Athens, the flappers were the young, good-looking boys of the day who had some excuse to get away from their accompanying slave by stopping in at the doctor's office and there making the acquaintance of some dashing young athlete, who might prove profitable from an economic point of view.

We learn most of this from the orator Aeschines, in his speech against Timarchus, which was delivered in 345 B. C. This speech throws an interesting light on the connection of the medical profession in Greece with what today might be called semi-prostitution or the pursuit of the "demi-vierges." According to Aeschines, Timarchus in his youth was a homoerotic prostitute of the most abandoned type. It is difficult for a modern man to follow Aeschines completely. He does his best to protect himself from the charge of being an old maid and a spoilsport. He goes to great trouble to point out that he has nothing unkind to say about homoerotic relations, as long as they are honorable. Nor he says, "Do I mean to suggest that every good-looking young male is a prostitute." He admits that he himself in his youth had been many times a lover and had written erotic poems to beautiful youths. What he objects to in the case of Timarchus is that Timarchus as a youth openly sold his favors, was kept by older men and once by a man who was a slave—a man who as a slave was the property of the city, but who had plenty of money. Sad to relate, this same Timarchus began his career of shame in a doctor's office, in the Piraeus, the harbor town of Athens. "As soon as Timarchus was past boyhood, he settled down in the Piraeus in the office of Euthydicus pretending to be a student of medicine, but in fact deliberately offering himself for sale." (See Aeschines in the Loeb edition, Section 136, p. 111. Also Section 135, p. 109. Also Sections 51-55, pp. 45-49 and especially Section 40, p. 35).

The orators and sophists were often the people who invaded the province of the medical men. Another famous orator, Antiphon (480-411 B. C.), tried to do a little "healing" by word of mouth, although he was not a physician. Greeks, of what we call today the intelligensia, looked down on religion and very often on medicine, too. In order to put something in the place of religion and medicine, they apparently, developed a kind of "new thought" treat-

ment. If anything went wrong at home or if anyone fell sick, they sent for a philosopher or a sophist and he would " speak beautifully to make them feel better." Plutarch, in his Lives of the Ten Orators, says of Antiphon that he procured himself a house in Corinth near the market place and informed all the people that he was able to cure them by means of his speeches.

In the field of archaeology, the contacts between Greek Medicine and Greek civilization are much clearer. We know now a great deal about the great shrines of Asclepius that existed in such places as Pergamon, Athens, Epidaurus, Cos, etc. At Epidaurus, three stylae were found by the great archaeologist, Kavvadias. The inscriptions on these pillars or stylae were published in 1883 and may be found in the " Inscriptiones Epidauri " with a commentary by Hiller von Gaertringen. (Inscriptiones Graecae, IV, 2, 1, 1929. Also in the Dittenberger Sylloge. See also Die Wunderheilungen von Epidauros . . . von Rudolf Herzog. Leipzig, Dieterich, 1931.) These inscriptions describe the various cures that were said to have taken place in the temple. They were apparently official inscriptions, put up by the political authorities, as is shown by the official character of the style. They are, in no sense, medical documents, but the record of miracles. Without any desire to judge the objective existence of these happenings, the Epidaurean miracles must be classified together with similar other so-called miracles that have taken place at Lourdes and at St. Anne de Beaupré, just outside Quebec. The value to the medical historian consists largely in the various pathological conditions that were miraculously cured. Among these are abscesses and swellings, miraculous surgical operations, obstetric cases, diseases of the eye, paralyses and lameness, and even speech defects.

To the general historian, these inscriptions are witnesses to the mental reactions of the period and they belong with all the other more or less contemporary records of wonder-working temples and priests and wise men, such as Apollonius of Tyana or the clever impostor, Alexander, who was described so cleverly by Lucian. Real scientific medicine had probably no direct contact with these miracle healings. They belong, however, to that type of primitive magic medicine, which is always with us and which exists as definitely

today as it did when people were miraculously cured at Epidaurus or at Pergamon. Perhaps, the best illustration of the spirit of those days which is indeed far from the age of Classical Greece is the experience of the sophist, Aristides, who was a typical neurasthenic and who sought health at Epidaurus, returning again and again, just as a modern neurasthenic returns to Wiesebaden or Aix-les-Bains, where strict régime, baths and exercise help his psychasthenia by regulating his life and his body. (Aelius Aristide et la Sophistique dans la province d'Asie au II Siecle de notre Ere" par Andre Boulanger. Paris, E. de Boccard, 1923, pp. 127 ff.)

Aristides lived during the 2nd Christian Century and was probably at Epidaurus about A. D. 147. Although a distinguished orator and politician, he was ready to believe anything and while at Epidaurus discussed his dreams with his fellow patients as zealously as the most recent convert to Freudian psychoanalysis, who keeps a dream book and rushes off to his psychoanalyst the minute that he has a peculiarly distinct vision that suggests some new frustration of his or her libido.

So our knowledge of these great "Kurorten" in definite parts of Greece not only throws a clearer light on the mental attitude of people who were sick or thought themselves so, but also shows us how limited the range of human reactions and adaptations really are, since men and women of certain types react today in the same way as they reacted in Greece so many hundred years ago.

Thanks to Archaeology, we are able to reconstruct these great Spas or health resorts, that had not only hotels in which to house the visiting patients, not only a temple in which dreams were to be dreamed and medical miracles performed, but also a theatre and a race course to keep the patients amused. Through these great foundations streamed generations of men and women and if the medical results attained there may not have been entirely approved by the scientific physicians of the 4th Century B. C., still results were obtained and without the knowledge of these Spas that medical history brings us, we should not be able to appreciate a definite part in Graeco-Roman civilization.

Greek History must, for instance, take account of Olympia and of the Olympian games, even though it does not know all the names

of the victors. In the same way, the historian must take into account Epidaurus and the other great shrines of Asclepius, especially the shrine at Cos, Epidaurus and at Athens. In these shrines, we find all sorts of ex-votos that have a distinct medical significance. The ex-voto of a man who had suffered from some intestinal disturbance and who hung up in the shrine the representation of his own inwards affords us indirectly a knowledge of what the people of that time know about the intestines and their situs. In the same way, a thousand years from now, some historian, in trying to reconstruct our present century, may find at St. Anne de Beaupré in Quebec very useful material. For there are hung up all sorts of crutches, various kinds of suspensories and hernia belts, eye glasses, wheel chairs and all the panoply of illness. He would be able from this material almost to reconstruct the catalogue of a modern firm that sells instruments and hospital appliances.

The best description of the life of a patient at a place like Epidaurus may be read in Walter Pater's "Marius the Epicurean" (Volume I, Chapter 3). Marius, himself a distinctly psychasthenic character, goes in despair to an Aesclepieion, where by suggestive mental treatment, combined with hydrotherapy and exercise, he achieves a complete cure.

There is a collection of verse called the Palatine Anthology, so named because it has come down to us in one unique manuscript, at present in the Palatine Library at Heidelberg. It was put together in the 10th Century by Cephalus, who drew from three older collections of different dates. One was the Stephanus or Wreath of Meliager, collected during the 1st Century B. C. and consisting of poems belonging to the classical period of Greek literature (that is, the 5th-3rd centuries B. C.) Then, there was another Wreath probably collected in the reign of Augustus. Finally, Cephalus used the cycle of Agatheas, put together during the age of Justinian and containing contemporary work. Besides these three main sources, Cephalus added to his collection a number of well-known epigrams, the Musa Puerilis of Strato (Book 12), a number of love poems and the epigrams of Palladas of Alexandria who wrote in the 6th Century A. D.

The Palatine Anthology, therefore, is something like one of our

thick household books of English poetry. It is a collection of great interest and of still greater beauty. It gives us the thoughts of hundreds of versifiers on all sorts of subjects. It represents, in a way, all Greek history just as one of our household books of English verse would represent indirectly a history of the English speaking people.

In the Anthology, the physician has a definite place. You will find him side by side with the politician, with the lawyer, with the man of business, with the soldier. He is part of the whole unity. It is true that the jokes made about him are exceedingly ancient. He is always killing his patients and always trying to cover up his mistakes. But there he is and if one subtracted from the anthology the verses dealing with medicine and with physicians, one would still have a lot of good verse, but one would also miss a very great deal.

It is the same way with the whole question that I have tried to discuss in so imperfect a manner. The knowledge that we have of Greek Medicine, taken from the Greek medical texts beginning with the Hippocratic Corpus and going down to the little book on diet by Sethus, as well as the knowledge that we possess of the Greek physician himself, taken from these same writings and pieced together also from contemporary literature—all this assembled information is a component part of Greek civilization, just as the epigrams on physicians are integral parts of the Palatine Anthology. You might know nothing at all about Greek Medicine and still be able to know a great deal about Greek History, but that great deal would not be the whole. Therefore, our study of Greek Medicine and of Greek physicians helps us to achieve as complete a picture of Greece in her glory and in her decadence as is possible for the human mind of a modern historian.

PLATE I

TEXTS AND DOCUMENTS

A STUDENT'S EXHIBIT ILLUSTRATING THE HISTORY OF PHYSIOLOGY

The exhibit described in the following pages was the culmination of a seminar course given by my associates, Drs. Temkin, Oliver and Edelstein, to a first-year student class. In the beginning of the course, a brief survey of the development of anatomy was given as an introduction. In the following weeks, the principal fields of the history of physiology were presented by the students and discussed by the group. The exhibit attempts to illustrate graphically some of the salient features in the evolution of physiology. Similar exhibits have been made in previous years on the subjects of anatomy and pathology (*Bulletin of the Institute of the History of Medicine*, 1933, vol. I, pp. 193-234; 1934, vol. II, pp. 447-476). Here again the students have done the entire work themselves; they have written the present catalogue, which was completed and edited by Miss Helen C. Brooke.

HENRY E. SIGERIST.

PLATE II

THE HISTORY OF PHYSICS AND CHEMISTRY

In writing such a brief review of the history of so tremendous a field as that of chemistry and physics, it is obviously quite impossible to go into any detail—in fact, it is hardly possible to enumerate the absolutely indispensable points in so short a space. For this reason I have divided up the history into periods, which, after all, are quite distinct in a general sort of way, and I shall attempt to give at least the trend of thought in physical science during those periods. Of course, it must be understood at the very outset that these periods are purely arbitrary—the system herein employed is just one of the many possible.

A major obstacle is presented by the fact that it is quite difficult to demarcate the boundaries of chemistry and physics. It is impossible to separate them, from the view of past history, and so our history cannot be a cleanly divided double-history, so to speak. The history of chemistry is inevitably fused with, and part of, the history of physics. For this reason, this is really a history of chemistry, and, except for a few general remarks, physics will have to be excluded almost completely.

In antiquity (the period of the philosophers), there was no separation between chemistry and physics. The ancient philosophers were interested in the fundamental nature of matter and in the transformations of this matter. It is evident that they drew no line between physics and chemistry. Throughout the Middle Ages, too, chemistry and physics were really but one science and no clear separation is possible. It is not until along about the end of the 15th century and the beginning of the 16th, that there was a real separation of the two. Here we find, on the one hand, men like Copernicus, Brahe, Kepler, Galilei, Newton; on the other, the Iatrochemists, and later the Phlogistians, who in turn were followed by the modern chemists. For purposes of exposition, I start the period of modern chemistry with Lavoisier. This, again, is purely arbitrary and is really a matter of personal opinion. And so the two sciences, physics and chemistry, trod their respective paths, quite distinctly separated from one another. However, since 1880 they

have again united and, I believe, it is rather obvious that today they move along the same path.

I think it is fair to say that the most outstanding characteristic of the philosopher period is the lack of experiment. It was not necessary for a person to supplement, or test, his theories with experiment. If he had, in some way or another, carved a niche for himself in the current Hall of Fame, his words were accepted as gospel truth. Even today, of course, we are more apt to accept the ideas of a man who is considered an authority in his field—however, we know that, in general, he has gained his reputation as an authority by painstaking research and tremendous collections of data, so we feel that his ideas are based, in great part, on proven facts. Among the ancients, a man often obtained his reputation as an authority by his ability as an orator and a debater. The attitude was absolutely different from that which we have today. The ancient theorist considered it below his station to set up apparatus, design experiments, and so forth. He could do nothing which had any semblance of manual work. All he could do was to theorize, for pure thought alone was held worthy of the true philosopher. Thus, only in a period such as this was it possible to have such theoretical speculations as those of Thales, Anaximenes, Anaximander, Leukippos, Demokritos, Empedokles, Herakleitos, Parmenides, and many others. One thing they all had in common, and that was that they were all searching for the fundamental nature of matter. The earliest of these seized upon one element, for example, air, or water, or fire. Later, they came to look upon four elements, viz., earth, air, fire, and water. Then, with Demokritos and Leukippos, we have the "atomic theory" of the ancients. It is very interesting to go into the details of these theories, as they are excellent examples of the trend of thought during the period.

The next period of importance is the Period of Alchemy, which had its beginning back in the philosopher period and continued throughout the Middle Ages. This is probably the period which has been most sweepingly condemned of all the periods in chemical development. It is true, of course, that many of the alchemists were no better than common cheats, but this must be overlooked in great measure. The fundamental idea of the alchemists was as follows.

They believed that there was a certain prime substance, or "materia prima," which was present in all things in a contaminated state. It was only necessary to remove these contaminations in order to get this "materia prima" in a purified state. (The processes of purification were sublimation, distillation and calcination). Once this "materia prima" was isolated in the pure state, it was apparently identical with the philosopher's stone, which had all sorts of powers. The baser metals could be changed to gold by contact, all diseases could be healed by it, and even the character of the fortunate discoverer could be regenerated by it! This seems rather absurd to us today, but really it isn't as absurd as it seems. As Dr. Moore says, "it is the essential nature of chemical nature that one substance with certain properties disappears while another with different properties takes its place, and there was nothing in the knowledge of the times from which one had the right to conclude that it was any more impossible to obtain gold from lead, than to obtain lead itself from litharge or mercury from cinnabar. In fact, the recent preparation of helium from radium puts the logic entirely on the side of the alchemists. Chemistry is an experimental science, and the only way to find out whether it is practicable to get gold from lead is to try it. We owe it to the alchemists to acknowledge that they did try it, with crude means, it is true, but with endless patience and much needless repetition. The pity of it all is that all their efforts were so wasted by secrecy that they could show few results of value in a whole thousand years."

Immediately following the Period of Alchemy is the Period of the Iatrochemists, the most important of whom were Paracelsus, Agricola, Van Helmont and Glauber. The Iatrochemists believed that all the phenomena of life and disease are based on chemical action. Most of these men were physicians and accordingly treated their patients from this point of view. The period is a very important and interesting one and is really well worth serious consideration. It began at about the beginning of the 16th century and lasted approximately a century and a half.

Georg Ernst Stahl (1660-1734) is known as the founder of the phlogiston theory. At least, he was the one who made the phlogiston theory a really workable hypothesis. The fundamental idea of the

Phlogistians was that all substance contained a constituent which escaped when the substance burned. This constituent, called phlogiston, was thought to be a definite chemical component. The Phlogistians were not bothered by the fact that no one had ever seen phlogiston, or that nothing was known about it except that it escaped on burning. We must remember that chemical philosophy had not yet reached the quantitative aspect that it has today. We shall see how this theory broke down, as soon as quantitative methods were applied. There were a number of major faults in the theory. In the first place, it was known that air is required for combustion. The phlogistians moulded this into their theory by saying that the phlogiston did not just escape in the process of burning—it united with the air in some way. Thus, in the absence of air, there could be no burning because the phlogiston would have nothing with which to combine. In the second place, how is it possible that the oxide (calx) of a metal should weigh more than the metal itself, if something is lost in the burning? The Phlogistians answered this by saying that phlogiston had a " negative weight "—that is to say, the more phlogiston a substance has, the less it weighs. The sad lack of quantitative methods is apparent.

Nevertheless, we must not be too harsh with the Phlogistians, who, by the way, were such eminent scientists as Becher, Boerhaave, Black, Cavendish, Scheele, and Priestley. The theory, in spite of its shortcomings, proved a very necessary coordinator of all the prevailing chemical knowledge. This meant a great deal when we consider in what a confused state chemistry had been left by the alchemists. At last, here was some sort of a system which enabled chemists to make generalizations. The making of generalizations which can be tested is obviously an important step in scientific progress.

With the breakdown of the phlogiston theory, we come into the modern period of chemical science. As I have said above, I begin this period with Lavoisier (1743-1794), because it was really his work which was the most effective single factor in the disruption of the phlogiston theory. This period following the phlogiston theory is marked by its quantitative attitude, by its scientific approach in all respects. New fields of chemistry spring up, some

of which are not really new except in the sense that nothing much of importance had been done in them up to this time. Electrical chemistry got its real foundations at the middle of the 18th century. And later, in the work of men like Galvani, Volta, Davy, and Faraday. Organic chemistry made stupendous strides in the 19th century, as evidenced by such well-known names as Wöhler, Liebig, Dumas, Gerhardt, Wurtz, Hoffman, Kekulé, Cannizzaro, and many others. The advances made by physical chemistry in the 19th century are so well-known that they need hardly be mentioned. The names of Gibbs, Arrhenius, Van t'Hoff, Ostwald, have become historical, it is true, but the work of such men is the basis of every experiment which we now do in physical chemistry.

Today we are still in the period initiated by Lavoisier. We have, of course, progressed enormously since his day, and, without a doubt, will continue to progress. Chemistry and physics have become inseparable, and it seems to me only a matter of a few years until the distinction between the two is completely wiped out.

BRUNO BARELARE, JR.

PHYSICS AND CHEMISTRY

Wall Exhibit

PLATE II

ISAAC NEWTON (1642-1727)

Engraving from a portrait by S. Kneller, 1689.

Newton was the highest expression of the dynamic trend of the 17th century—a mathematical scientist, a dealer in quantity. He applied science to practical purposes, made a familiar world out of hitherto theoretical mysteries. Modern physics and chemistry are the descendants of his experimental finesse.

COMPUTATION OF THE DEPTH OF A WELL

Johannes Stöffler (1452-1531)

Elucidatio fabricae ususque astrolabii a Joanne Stoflerino Justingensi viro Germano . . . Oppenheym, Köbel, 1512. From: Robert T. Gunther, *The Astrolabes of the World,* Oxford University Press, 1932, vol. II, p. 431. This illustration is one of the many in which Stöffler, a professor of mathematics at the then newly established University of Tübingen, demonstrated practical uses of the astrolabe.

DISTILLATION APPARATUS OF THE 16TH CENTURY

Michael Puff von Schrick

Von den uss gebrenten Wassern in welcher mass man die nützen und bruchen sol zu gesundheit der Menschen, Nuremberg, Jobst Gutknecht, 1523. From: Bibliotheca Bacchia . . . par André Simon, London, Maggs, 1932, vol. II.

CAMERA OBSCURA

Johannes Beverovicius (1594-1647)

Alle de Wercken soo in de Medecyne als Chirurgye, 'T Amsterdam, Jan Jacobsz Schipper, 1652.

CHEMICAL LABORATORY OF THE 17TH CENTURY

Johannes Baptista Porta (1536-1615)

Magia Naturalis, oder, Haus- Kunst- und Wunder-Buch . . . Nürnberg, Johann Zeiger, 1680.

CONSULTING-ROOM OF A 17TH CENTURY DUTCH PHYSICIAN

A painting by Gilles van Tilborgh (1625-1678?). In: Eugen Holländer, *Die Medizin in der klassischen Malerei,* Stuttgart, 1913.

MICROSCOPES OF THE 17TH CENTURY

Collection Nachet . . . Notice sur l'invention du microscope et son evolution, par Albert Nachet . . . Paris, Georges Petit, 1929. Used by such avid seekers after detail as Leeuwenhoek and Malpighi, with momentous results, these microscopes and their lenses come a long way from Euclid, who was one of the earliest observers of the general principles of light refraction.

CHEMICAL APPARATUS OF THE 18TH CENTURY

E. I. Morell, *Chemische Untersuchung einiger der bekanntern und besuchtern Gesundbrunnen und Bäder der Schweiz* . . . Bern, Emanuel Haller, 1788, p. 384.

MICROSCOPE OF THE 18TH CENTURY

From an atlas of microscopy, London, George Adams, 1787, Pl. II.

EARLY 19TH CENTURY CHEMICAL APPARATUS

" The Economical laboratory of James Woodhouse, M. D., Professor of Chemistry in the University of Pennsylvania." Recommended for its " cheapness, usefulness and ingenuity," and excellent distilling apparatus. James Parkinson, *The Chemical Pocketbook* . . . Philadelphia, James Humphreys, 1802.

CASE I

AN EASTERN ASTROLABE

Robert T. Gunther, *Astrolabes of the World,* Oxford University Press, 1932, vol. I.

DIALOGUE ON THE PTOLEMAIC AND COPERNICAN SYSTEMS OF THE WORLD

Le Opere di Galileo Galilei, Firenze, 1933, vol. VII.

PARACELSUS (1493-1541)

A portrait from *Erster Theil der Bücher und Schriften des . . . Philippi Theophrasti Bombast von Hohenheim Paracelsi . . .* Basel, 1589.

Paracelsus, one of the most misunderstood men in the history of science, realized long before the rest of the scientific world the significance of the chemical and physical sciences. His work was sometimes obscured in alchemical fanaticism and mystical philosophy, but its essential application to experimental science lived to influence later scientists.

OTTO TACHENIUS

Hippocrates chimicus qui novissimi viperini salis antiquissima fundamenta ostendit, Brunsvigae, Th. Henr. Hauenstein, 1668.

ANTONJ VAN LEEUWENHOEK (1632-1723)

Replica of his microscope, made by the Bausch and Lomb Optical Co., complete with lens.

Opera omnia seu arcana naturae . . . Lugduni Batavorum, Joh. Arnold Langerak, 1722.

GEORGE ADAMS (1750-1795)

Essays on the microscope . . . London, Hindmarsh, 1787.

ANTOINE-LAURENT LAVOISIER (1743-1794)

Portrait of Lavoisier and Mme. Lavoisier in his laboratory, from the painting by David. In: Eduard Grimaux, *Lavoisier, 1743-1794,* Paris, 1888. The first authoritative opponent of the phlogiston theory, Lavoisier produced a new theory based entirely on experimental deductions, and giving preeminence to oxygen and the phenomenon of combustion. With some collaborators, he undertook to simplify scientific nomenclature and adapt it to the needs of the time.

"DESCRIPTION OF AN APPARATUS FOR COLLECTING GAS FROM COAL, AND OF ITS USE IN LIGHTING MANUFACTORIES AND OTHER LARGE BUILDINGS."

Samuel Parkes, *The Chemical Catechism,* New York, 1818.

AMOS EATON, *The Chemical Instructor,* Albany, 1822.

C. J. S. THOMPSON, *The Mystery and Romance of Astrology,* London, Brentano's, 1929.

PLATE III

A HISTORY OF EMBRYOLOGY

PART I

ARISTOTELIAN EMBRYOLOGY

Along with other of the biological studies, embryology can claim its true scientific beginnings in the work of Aristotle. Although a century earlier one of the Hippocratic writers had, on the basis of observations, produced a body of embryological theory, his work seems too much in the realm of metaphysics and his conclusions too erratic to justify its coming under the category of science, in the modern sense of that term. There were times when Aristotle, too, misinterpreted facts, but his understanding of living things was far more penetrating than that of his predecessors, his observation was combined with keener judgment. The very vastness of his knowledge, a body of facts well-classified, and amazing in their accuracy and detail, provided for a greater margin of truth than of error. Philosophy and science in the 4th century B. C. were still too closely blended for Aristotle's work, advanced though it was, to lose all the marks that would link it to that of the ancient natural philosophers, and this influence of his forerunners is as apparent in his treatises dealing with embryology as in other divisions of his writing.

Aristotle's knowledge of facts concerning generation came from the observation and dissection of widely varying types of animals, along with a careful study of the developing chick embryo conducted over the entire period of incubation. In reference to the last, Taylor has said that Aristotle's work contains every detail that could be listed without bringing the microscope into use. The source of his theoretical embryology is in the early Hippocratic writing which sets forth that male and female contribute equally to the formation of the embryo, and that the menstrual blood provides for the nourishment and development of the young organism within its mother's womb. Aristotle disagreed to the extent that the female, representing the passive principle, contributed the material (i. e. menstrual blood "or that which is analogous to it in bloodless ani-

mals") from which a new organism could develop. And, he maintained, the semen of the male contained the active principle that was to give the embryo its shape. Thus, although both sexes contributed to the inheritance of an individual, the female provided simply the plastic element that was formless until acted upon by the dynamic principle of the male. The development of the embryo was a mechanical one that proceeded according to formula once fertilization had occurred. One organ in the body having started to develop, it was the signal for another to begin to take shape. For these reasons Aristotle had no belief in preformation but held that every animal had its origin in substance without form. Nor did these arguments support spontaneous generation.

His theory of the different souls that possess the embryo at various stages appeals to Needham as a foreshadowing of the recapitulation theory, for Aristotle claimed that the first soul was purely vegetative (since the embryo in its early stages was surely as much alive as a plant). The second was the animal soul and appeared as the embryo began to assume shape. The third entered when the organism was recognizable in its final form.

The medieval church used Aristotle's classification of the souls as the basis of their laws regarding the sanctity of foetal life. Animation was supposed to take place on the fortieth day in males and the eightieth in females. (Later it was made the fortieth day for both). Thus abortion was made a crime comparable to murder, and minds turned to the possibility of baptism for embryos dying *in utero*. St. Thomas of Aquinas held that after the fortieth day such baptism could save the soul, but there were many to oppose him.

Aristotle's theories of embryology, as did his doctrines in all other branches of learning, dominated the field to the time of the Renaissance. Science, so-called, was under the rule of logic, not under the guidance of experiment. Leonardo da Vinci was among the first to attempt to redeem embryological study from its long subservience to tradition and the dogma of scholasticism. The greater part of his findings came through mammalian dissection, a record of which he kept by notes and drawings. The sketches are beautiful pieces of work that show him to have been a painstaking

and acute observer. Most important among his discoveries, and one that could not be proved before a century had passed, was the recognition that the foetal circulation was independent of the maternal.

After Leonardo in the 16th century came a series of morphologists who were expert anatomists and knew much of comparative embryology, but yet whose work did little to further their science. They leave the impression of having been men who spent their efforts upon a minute study of the developing chick embryo and were familiar with its detailed structure, but whose greatest contributions were the fine illustrations to their books. The arguments contained in those books are in most part fruitless discussions that carry one back through the ages to Aristotle. To the last and most capable of these men, Fabricius of Aquapendente, came William Harvey as a young student. Thus, although Aristotelianism was not yet done with, its authority was already threatened.

ELIZABETH LONGLEY.

PART II

Undoubtedly the dominant figure of the seventeenth century in the field of embryology was William Harvey (1578-1657), a pupil of Fabricius at Padua. Although known almost entirely for his discovery of the circulation of the blood, Harvey is also important in the history of embryology, as the first man to use a really dynamic attack. In addition to making observations of remarkable accuracy, he is continually seeking for the causes of what he sees, always asking himself "how" and "why." In short, he is the first man since Aristotle to study embryology from a physiological point of view.

Harvey's book on generation, *De Generatione animalium*, published at London in 1651, is a collection of researches which he had been carrying on for a number of years. He describes with great accuracy the chick's genital organs, its eggs, and the developing foetus; and he reports upon some experiments on hinds and dogs, the genital organs of which he had dissected. As a result of these

observations and experiments, he draws certain factual and theoretical conclusions:

1. The egg is the common origin of all animals; there is no such thing as spontaneous generation.
2. There is no coagulum formed in the uterus after copulation, a premise of Aristotle and the Epicurean physicians.
3. Development is by epigenesis, that is by progression from the simple undifferentiated to the complex highly differentiated, rather than by a mere enlargement of parts already formed.
4. The cicatricula, a spot on the yolk-membrane, is the point of origin of the embryo.

He also set his predecessors right on a great number of morphological facts concerning generation.

Despite these very significant contributions, however, Harvey's chief claim to recognition in the history of embryology lies in his orderly method of study, by direct observation or experiment, and in his dynamic point of view.

Shortly after Harvey's death embryology took great steps forward under the guidance of such able investigators as Malpighi, de Graaf, and Swammerdam. These men used the microscope, and with its aid were able to push back the story of development to its very earliest stages. De Graaf demonstrated the mammalian follicle for the first time. Although he thought this to be the egg itself, this is a very definite landmark in the history of embryology.

These men had much better imaginations than did Harvey;—they thought they saw miniature individuals, already completely formed, even in the unfertilized egg. This initiated a controversy between those who believed that development was merely an enlarging of a preformed miniature and those who followed Harvey in saying that development was epigenetic in character.

In fact there even grew up another school of preformationists, the animalculists, championed by Leeuwenhoek, the discoverer of spermatozoa. The members of this school fancied that they saw little animals and men in spermatozoa, and therefore postulated that individuals were completely preformed in the spermatozoa, the eggs being merely for nourishment.

This controversy occupied a dominating position in embryology until the second half of the eighteenth century, when it was finally settled in favor of epigenesis by the work of C. F. Wolff. He presented numerous cases in which he could see the organs of the body actually taking shape; there was no longer any possibility of development being merely a growth of pre-existent parts.

The next great advance in embryology came with the discovery of the human ovum in 1827 by Karl von Baer. With this work, the main features of development as we know them today were established. Although the nineteenth century has been a most productive one in embryology along with many other fields, a large part of the work following that of von Baer has been an elaboration of the fundamentals laid down in the seventeenth and eighteenth centuries.

W. H. Horwitz.

EMBRYOLOGY

Wall Exhibit

Plate III

Aristotle (384-322 B. C.)

A portrait from an ancient sculpture. Aristotle contributed a tremendous wealth of material on comparative embryology, making a classification of animals according to their embryological characteristics. He was also much interested in the question of preformation and the contribution of the two sexes to the development of the foetus, which went through so many odd phases until as late as the 18th century A. D.

Foetus in Utero, From a 12th Century Manuscript

MS. Copenhagen 1653, the Royal Library. Karl Sudhoff, *Tradition und Naturbeobachtung* . . . , Leipzig, 1907, Taf. XV.

Foetus in Utero, From a 13th Century Manuscript

MS. Monacensis 161. Karl Sudhoff, *Tradition und Naturbeobachtung* . . . , Leipzig, 1907, Taf. XVII.

Leonardo da Vinci (1452-1519)

A *foetus in utero,* showing membranes, and attachment of the placenta to the wall of the uterus. *Quaderni d'Anatomia* . . . Christiania, 1911, vol. III. In spite of Leonardo's astute conclusions from his closely observed dissections, the old traditions of the growth and

nourishment of the *foetus in utero* continued beyond his day. One of his most interesting observations was a recording of embryonic growth—a premature quantitative outlook. His amazing break away from traditional views at so early a period makes him an object of absorbing interest to the historian of medicine.

HIERONYMUS FABRICIUS AB ACQUAPENDENTE (1537-1619)

Two plates from "De formatio ovi et pulli," from the *Opera omnia anatomica et physiologica*, Lipsiae, 1687. (First published in 1604.)

Portrait of Fabricius.

Fabricius continued to follow the traditions of Galen, though the trend was in the opposite direction. Though he made a good comparative study of embryology, and his drawings of the development of the chick embryo were remarkably clear and accurate, he allowed himself to be led away from the main issues of the subject, and ignored the obvious conclusions to be drawn from what he actually saw.

WILLIAM HARVEY (1578-1657)

Portrait.

In his *Exercitationes de generatione animalium*, it was necessary for Harvey to mend the errors in the field made by his master Fabricius ab Acquapendente, or rather, to draw more correct conclusions from the observations of Fabricius. Harvey was an exponent of the *theory* of epigenesis, though unable to prove it through lack of a microscope. He advocated in part the idea of recapitulation as Aristotle had propounded it, and demonstrated, after centuries of bickering, the focal point of embryonic development, in the cicatricula; thereafter, like Leonardo, he noted carefully the quantitative aspects of embryonic growth.

MARCELLO MALPIGHI (1628-1694)

Two plates from *De formatio pulli in ovo*, in the *Opera omnia*, London, 1672. The tremendous importance of this work was a result of Malpighi's use of the microscope, which he focussed on the cicatricula from the first moments of incubation. For the first time, embryological drawings showed the initial appearance of the neural groove, the optic vesicles, and the blastoderm. For the first time, an embryo was depicted as it really was, uninfluenced by traditional beliefs.

CASE II

HIPPOCRATES

De la génération, de la nature de l'enfant, from Emile Littré, Oeuvres d'Hippocrate, Paris, 1851, vol. VII.

ARISTOTLE (384-322 B. C.)

De animalium generatione liber I, Works of Aristotle, Paris, 1854.

EUCHARIUS ROESSLIN

De partu hominis, et quae circa ipsum accidunt, Francofurti, apud Chr. Egenolph, 1532. An illustration showing foetus and placenta. Though Leonardo da Vinci's admirable work was done a good twenty years before, the first edition of Rösslin's *Rosegarten,* published in 1513, carried the old Soranus tradition into the 16th century, reproducing drawings of the *foetus in utero* from mediaeval manuscripts. This illustration, however, shows the beginning of the Renaissance influence on the old schematic presentations of the human body.

HIERONYMUS FABRICIUS AB ACQUAPENDENTE (1537-1619)

De formatio ovi et pulli, from: *Opera omnia anatomica et physiologica,* Lipsiae, 1687. (First edition, 1604.)

WILLIAM HARVEY (1578-1657)

Exercitationes de generatione animalium, Amstelodami, apud Ioannem Ianssonium, 1651, the same year as the London first edition.

Anatomical exercitationes concerning the generation of living creatures . . . London, James Young, 1653. The first English translation was made from the Latin by Harvey himself, with the assistance of a young physician named Martin Llewellyn.

ANTON DEUSING

Genesis microcosmi, seu, de generatione foetus in utero . . . Amstelodami, 1665.

REGNIER DE GRAAF (1641-1673)

De mulierum organis generationi inserventibus tractatus novus . . . from: *Opera omnia,* Lugduni Batavorum, ex officina Hackiana, 1677. The discovery of the mammalian follicles, named for their identifier, was his greatest contribution to embryology, though he took them for eggs. The illustration shows de Graaf's experiment in developing the foetus in the horn of the uterus, meant to demonstrate the ovarian origin of the embryo.

KARL ERNST VON BAER (1792-1876)

De ovi mammalium et hominis genesi, Leipzig, 1827. Von Baer was a formulator and clarifier of the recapitulation theory, and established the real identity of the Graafian follicles.

F. J. COLE, *Early Theories of Sexual Generation,* Oxford, 1930.

Some illustrations of the doctrine of preformation, which was developed to its fullest extent in the 17th and early 18th centuries. This doctrine occupied the minds of embryologists, serious and otherwise, for centuries, taking on, at times, the aspect of a feud between the ovists and the animalculists.

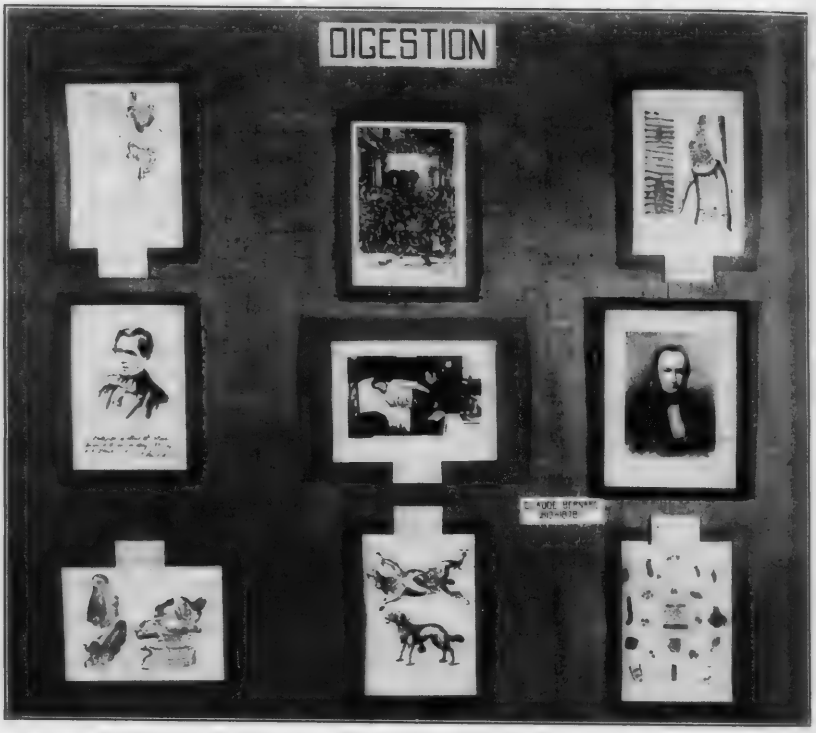


PLATE IV

HISTORY OF THE PHYSIOLOGY OF DIGESTION AND METABOLISM

Part I

One of the vitally important and interesting fields of medicine is metabolism. It is to Hippocrates, one of the foremost cosmologists in Greek philosophy, that we owe the earliest investigations in this field. It is on the basis of his conclusions that Galen made his investigations. Since very little is known of the various successors of Hippocrates, it is on the basis of Galen's conclusions that we have built our theories.

Galen was both a philosopher and a scientist. He adhered to his principle that there is a positive relationship between logic, physics and medicine. Metabolism is one of the fields in which Galen made remarkable progress.

Metabolism is necessarily thought of in terms of food. It is natural that mammals should be inclined to particular foods and averse to others. Thus, as Galen terms it, attractive and repulsive factors exist in everything.

Now let us consider Galen's system of absorption. The portal system carries the blood and the food from the intestines to the liver and from there it is distributed throughout the entire body. Below are the principles that Galen used to explain metabolism:

	Elements	*Qualities*	*Humors*	*Faculties*
1.	Fire	Hot and Dry	Yellow Bile	Attractive
2.	Earth	Cold and Dry	Black Bile	Retention
3.	Air	Hot and Moist	Blood	Alteration
4.	Water	Cold and Moist	Phlegm	Expulsion

Galen concluded with the help of previous investigations that there was a certain relationship between the body and the known physical elements (fire, earth, air, and water). Galen thought that everything consisted of four elements, four qualities characteristic to these elements, four nutritive faculties, and four humors, yellow bile, black bile, blood, and phlegm.

While the food was passing through the liver, the yellow bile, which was hot and dry, was absorbed in the gall bladder. After the food passed from the liver the black bile was taken out by the spleen. As the blood containing the phlegm, which is cold and moist, passed through the body, the phlegm was extracted, and purified blood, which is hot and moist, remains in the system.

Now let us consider the faculties of attraction, retention, alteration, and expulsion by which the body is nourished. As the rich blood rushes through a tissue, the nourishing portion is either absorbed by the faculty of attraction, or is passed on by this force of repulsion. Both the food and the tissues possess the various dynamic qualities. If the qualities of the tissue are stronger than those of the food, the food is absorbed. Galen considered the qualities involved in attraction as hot and dry because heat increased the power of attraction, which might be illustrated by the rapid emptying of a stomach resulting from exercise which he might have considered heat production.

If the food is attracted, a second factor, retention, holds the food in the tissue. Retention is characterized by cold and dryness because dryness delays movement and cold appears to favor muscular contraction. There is next the factor of alteration, which can be illustrated by the changes taking place in the boiling of an egg. During this process the food may be changed into tissue, it may nourish other tissue, or it may be broken down and part of it used, while the other part might be expelled, which brings into play the last faculty, expulsion. From Galen's time we pass through the dark ages of culture, during which no new ideas were added to those of Galen.

JOE C. GILBERT.

PART II

Let us take a telescopic glance at the history of the physiology of digestion. In the first century the knowledge accumulated in the field was summarized by Celsus who stated that some physicians claimed food to be "concocted in the stomach by attrition"; that

others felt digestion to be a putrefactive process; and that still others felt like Hippocrates that "concoction is the effect of heat."

For some fourteen centuries, European medicine was dominated by the work of a man who lived in the second century—Galen. Interesting among his writings is the description of his experiments on pigs which he fed a mixture of flour and water, and opened after a few hours to observe the gastrointestinal tract at work. He recognized the phenomena of mastication, salivation, gastric secretion, pyloric sphincter action, peristalsis, and biliary secretion. He felt the function of the stomach to be the exertion of a pull on the food from the mouth, the storage of useful food in its walls, and the rejection of remaining material into the intestines.

Until the sixteenth century physiology was little more than the interpretation of Galen, but the Renaissance brought a man who dared break with tradition to the extent of setting up a classification of foodstuffs into oils, vegetable products, and salts. This man, Paracelsus, thus pointed out for later workers a connection between digestion and the rising science of chemistry.

Two diametrically opposed new physiological schools began to arise in the seventeenth century—on the one hand, the Iatrophysicists who maintained that the bodily functions are solely physical phenomena, and on the other hand, the Iatrochemists who explained physiology entirely on a chemical basis.

Jean Van Helmont may well be considered the founder of the latter group. He believed all changes occurring in the body the result of ferments. Through the dense metaphysical mazes of his chemical exposition of physiology, the fact that he recognized gastric acidity shines out, although it had to wait two hundred years for affirmation.

The leading Iatrochemist after Van Helmont was Sylvius, known also as Dubois. He is best known as the teacher of Stensen, Wharton, Wirsung, and de Graaf—men whose contribution to the study of digestion lay in the direction of the pancreatic and salivary glands. Sylvius believed salivary action the most important digestive process.

Sanctorio was one of the earliest exponents of Iatrophysics; he is sometimes called the father of modern metabolic studies. Borelli,

a pupil of Galileo, was well known as a member of the Iatrophysical school; he believed digestion largely the result of the crushing and grinding of the food by the gastric musculature.

Boerhaave was the first student to look at the newly-accumulated evidence as a whole, rather than from the limited point of view of one school. In addition to being the founder of the Eclectic School, he is remembered for his theory that digestive juices act partly by chemically dissolving food. Boerhaave's pupil, Haller, was the author of what has been called the first text-book of modern physiology. In it he includes complete references, gives all existing points of view, and "complete" physical, chemical, and microscopical evidence. Saliva is recognized as an aid to deglutition; the action of bile on fats is observed; and the important rôle of the stomach is considered.

In France Reaumur (working with a bird which rejects foreign material from its stomach after a period in which the digestive juices have had a chance to work on it) established the antiputrefactive nature of the gastric secretion. Spallanzani made studies on his own digestive system which led to the confirmation and elaboration of the findings of Reaumur.

In 1822 an accidental shot in a trading post in the Michigan Territory caused a permanent gastric fistula in a young Canadian, Alexis St. Martin. William Beaumont, a United States Army surgeon, treated the man and conceived the idea of using him as the subject of physiological studies. The story of the relations between the ambitious doctor and the cranky patient furnishes one of the most pitiable, and yet most laughable, episodes in the history of our subject. A series of remarkable observations was made on gastrointestinal motility, the action of gastric and intestinal juices *in vivo* as well as *in vitro*, the effect of psychic reactions on digestion, and the like. (Before Beaumont, John Young of Baltimore had established the acidity of the gastric juice, and the Englishman, Prout, had shown hydrochloric to be the acid present.)

The work of Claude Bernard in France did for our understanding of intestinal digestion what Beaumont had done with respect to gastric processes.

The last half-century or so presents a scene of such great activity

that we cannot even scan it in a summary such as ours. Heidenhain in Germany, Pavlov in Russia, Bayliss and Starling in England, Sorensen in Denmark, Mall, Cannon, Carlson, and Ivy in America are but a sprinkling of the names of the scientists whose contributions to our field are scattered in profusion in the stacks of the library.

HELEN GOLDEN PAULSON,
LESTER LEE HASENBUSH.

DIGESTION

Wall Exhibit

PLATE IV

ANDREAS VESALIUS (1514-1564)

Anatomical drawing of the small and large intestines from *De humani corporis fabrica libri VII*, Basiliae, 1543. Vesalius was purely an anatomist, but, as is well known, he made possible the physiology of the future by his new conception and exposition of the gross anatomy of the human body. His physiological views were entirely Galenic, and seem primarily concerned with adapting his observations to the humoral idea. He had seen both conglomerate and lymphatic glands, but did not differentiate, since he was unaware of the existence of ducts.

Reproduction of the title-page of the *Fabrica* of Vesalius (1543), showing Vesalius, surrounded by colleagues and students, dissecting the abdominal organs of a human cadaver.

REGNIER DE GRAAF (1641-1673)

De succi pancreatici natura et usu, in: *Opera omnia*, 1677, tab. III (First published in 1664). This picture shows the famous experiment performed on a dog by de Graaf to obtain pure pancreatic juice, the results of which were treated in a speculative fashion that detracted from its value, and resulted in its neglect until the time and work of Claude Bernard. Its technical ingenuity is illustrative of the dynamic spirit of the 17th century—the tendency to analyze from a point of view of quantity and motion.

THOMAS WHARTON (1614-1673) and NICLAUS STENSON [Steno] (1638-1686)

Adenographia: sive glandularum totius corporis descriptio, Londini, 1656. A plate showing the original figures of Wharton's duct of the submaxillary gland in a calf.

Observationes anatomicae quibus varia oris, oculorum et narium vasa describuntur, novique salivae . . . Lugduni Batavorum, J. Chouët, 1662. Plate showing parotid duct and labial glands in the mouth of a calf.

Both the illustrations are on one plate, from: William Stirling, *Some apostles of physiology*, London, 1902, p. 50.

Wharton, though he recognized the function of this duct that was named for him, did not realize its significance, only giving the nerves connected with the gland undue importance by crediting them with conveying thereto the *succus nerveus*, a new name for animal spirits.

Stenson, who studied under both Bartholinus and Sylvius, and had good sound training in glands as well as in proper methods of research, saw the difference between ductless and secretory glands. He attached great importance to the thing Wharton had observed and ignored—that saliva-producing material is brought to the glands by the arteries. He also saw that this material is absorbed by the gland when the blood is passing through the capillaries into the veins. He used a low-powered microscopic lens.

JOHANN CONRAD PEYER (1653-1712)

De glandulis intestinorum eorumque usu et affectionibus, Amstelodami, 1681. A plate showing "Peyer's Patches" in the small intestine, and solitary follicles in the large intestine. Payer identified these small glands as conglomerate, and stated that they must secrete digestive juice into that section of the digestive apparatus.

A portrait of Alexis St. Martin, in 1871, the famous and elusive patient who provided William Beaumont with an experimental laboratory by getting himself full of buckshot.

Imaginary drawing of Beaumont extracting gastric juice from the fistula in St. Martin's stomach.

CLAUDE BERNARD (1813-1878)

A portrait.

Claude Bernard was trained in the traditions of the School of Magendie. Speculation was repudiated, and experiment was conducted towards the discovery of measurable physiological laws. Bernard's *Introduction à l'étude de la médecine expérimentale* is concerned to a great extent with the physiology of digestion and the laws of metabolism and its relation to the nervous system. With Bernard, chemistry and physiology were close collaborators, since his physiological experiments and observations made manifest chemical activity.

Case III

Galen on the Natural Faculties

Loeb Classical Series, with an English translation by A. J. Brock, London, Heinemann, 1916. In this book Galen deals especially with the physiology of digestion, nutrition and metabolism.

The portrait of Vesalius in the *De corporis humani fabrica libri VII*, Basiliae, 1543.

Jan Baptista van Helmont (1577-1644)

Oriatrike, or physick refined . . . a new rise and progress of phylosophy and medicine . . . London, 1662 (First published, *Ortus medicinae, id est initia physicae inaudita . . .* Amstelodami, Elzevir, 1648). Van Helmont was an empirical scientist who, imbued with the chemical concepts of Paracelsus, was concerned with the morbid processes within human organs.

Franciscus [Deleboë] Sylvius (1614-1672)

A portrait, engraved in 1659 by J. L. Durant.

Disputationum medicarum decas . . . functiones naturales . . . In: *Opera medica*, Genevae, Samuel de Tournes, 1693 (First published in 1663). Sylvius was an ardent supporter of the new physiological studies based on anatomy. His chemical speculations were influenced by the prevalent idea of fermentation, and the curing of chemical manifestations in disease by counteractive substances. He was instrumental in the growth of the iatrochemical influence on medical speculation.

Francis Glisson (1597-1675)

Tractatus de ventriculo et intestinis . . . Londini, Henricus Brome, 1677. His chief contribution to physiology was the introduction of the idea of irritability as a factor in motivating secretions from the liver, an idea which was extensively considered by Haller in the next century. Haller gave it a more specific meaning, where Glisson treated it from a somewhat speculative and philosophical standpoint. Sir Michael Foster (Lectures on the History of Physiology, Cambridge, 1901) has it that Glisson was the first to disprove the theory that muscles increased in size when contracted.

Regnier de Graaf (1641-1673)

Opera omnia, Lugduni, Ant. Huguetan, 1678. Drawing of the pancreas, showing entrance of common pancreatic and biliary duct into the duodenum.

[Philippe Hequet, 1661-1737] *De la digestion et des maladies de l'estomac, suivant le système de la trituration et du broyement . . .* Paris, Fournier, 1712.

EZEKIEL JOHN DORSEY

Dissertatio de nutritione . . . Edinburghi, 1776.

FRIEDRICH TIEDEMANN and LEOPOLD GMELIN

Die Verdauung nach Versuchen, Heidelberg und Leipzig, 1826.

RUDOLF HEIDENHAIN (1834-1897)

Neue Versuche über die Aufsaugung im Dünndarm, Pflügers Arch. f. Physiologie, Bonn, 1894, vol. LIV, pp. 579-631.

CASE IV

WILLIAM BEAUMONT (1785-1853)

Copy of the portrait of Beaumont by Chester Harding.

Notification of election to honorary membership in the Medical Society of the Territory of Michigan, March 3, 1825.

License to practise medicine in Vermont, June, 1812.

Certificate of copyright of first edition of *Experiments and observations on the gastric juice and the physiology of digestion.*

Articles of agreement between Beaumont and St. Martin, October 16, 1832.

Commission as surgeon in the U. S. Army, February 15, 1828. Signed by John Quincy Adams.

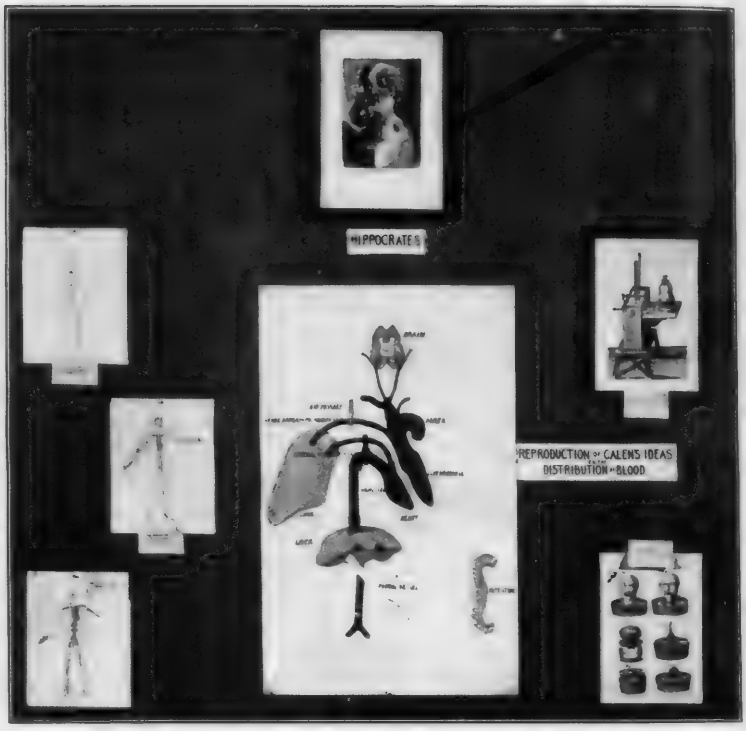
Letter from W. G. Eliot, Jr., Secretary of the Board of Trustees of the Medical Department of St. Louis University, apprising Beaumont of his election to their Chair of Surgery, October 4, 1836.

Letter from Alexis St. Martin, after an absence of several years, offering his services for experimental purposes, June 5, 1838.

(The foregoing documents are photostatic copies of originals in the possession of Washington University Medical School, St. Louis, Missouri.)

Experiments and observations on the gastric juice and the physiology of digestion, Plattsburg, F. P. Allen, 1833. A reprint issued on the occasion of the XIIIth International Physiological Congress in Boston 1929.

Photostatic copies of the first and second editions of the *Experiments and observations*, the latter being published in Boston, Lilly, Wait and Co., 1834.


HIPPOCRATES
REPRODUCTION OF GALENS IDEAS
DISTRIBUTION OF BLOOD

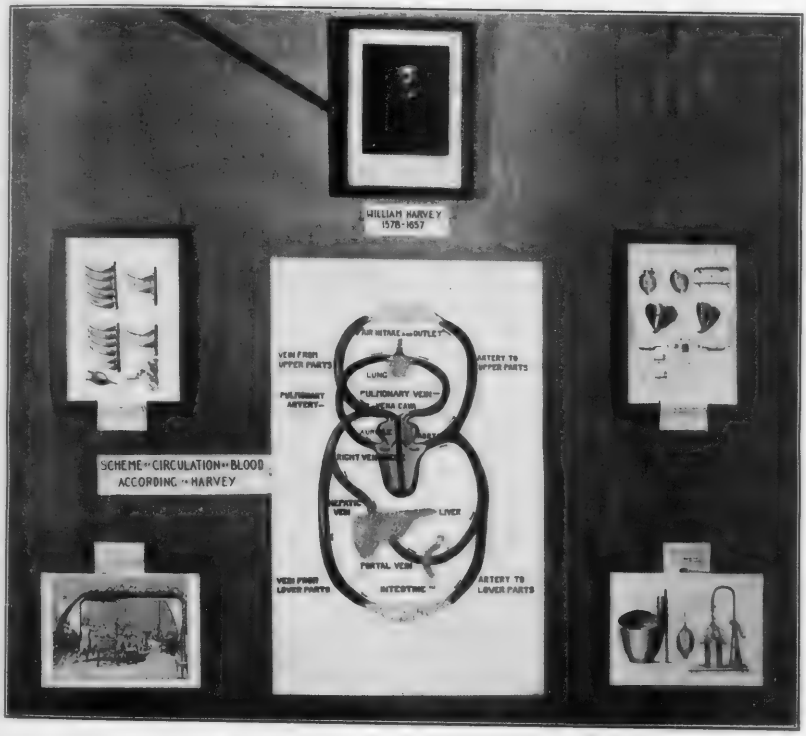

WILLIAM HARVEY
1578-1657
SCHEME OF CIRCULATION OF BLOOD
ACCORDING TO HARVEY
VEIN FROM UPPER PARTS
ARTERY TO UPPER PARTS
LUNG
PULMONARY VEIN
PULMONARY ARTERY
VENA CAVA
RIGHT VENTRICLE
HEPATIC VEIN
LIVER
PORTAL VEIN
INTESTINE
VEIN FROM LOWER PARTS
ARTERY TO LOWER PARTS

PLATE V

HISTORY OF THE DEVELOPMENT OF OUR KNOWLEDGE OF THE CIRCULATION OF THE BLOOD

The study of the activities of blood in the human body has extended over a considerable space of time during the memory of man. It has been influenced by various trends in civilization, philosophic tides, and periods of thought. The ancient philosophical conceptions, the limited means for anatomical studies, lack of microscopes and other scientific equipment, and the dominating power of tradition which retarded the advent of experimental research, all contributed to the slowing up of the development toward truth. Many great names are connected with this development. The most notable among them is that of William Harvey, dynamic factor in the establishment of modern physiology and experimental science.

A full treatment of the history of the development of man's knowledge of the circulatory system is impossible in a paper of this length. We merely list the outstanding men and events with their dates:

c. 1500 B. C.—Mention of the pulse and its use in diagnosis: in Egyptian writings.

Before 400 B. C.—Greeks attributed the pulse to the movement of blood in the vessels, and traced the movement to the heart. Similar use of the pulse in medical diagnosis. Study of the anatomy of the vascular system.

c. 322 B. C.—Aristotle believed in the predominance of the heart over the other organs of the body. He considered it the seat of intelligence and the source of body heat, the first organ in the body to live, and the last to die. He made no definite distinction between veins and arteries. He made his postulates of Man's soul. See below.

c. 300 B. C.—The Alexandrian school. Herophilus worked from the point of view of anatomy. The distinction between arteries and veins has become clear. Erasistratus, known as the father of physiology, expounded his "pneumatism" theory based on Aristotle's conception of the soul:

Man's Soul { Plant soul: liver—blood—veins—nutrition.
Animal soul: heart—arteries—function.
Rational soul: brain—nerves—higher nervous function.

The above is Erasistratus' expansion of Aristotle's idea, attributing definite locality to the various souls. Ingested food he believed to be converted into blood in the liver, and circulated in the veins. Air was believed to pass from the lungs to the heart where it was converted into the "vital spirit," or "pneuma," which was carried in the arteries to endow the organs with animal function. The part which went to the brain was further converted into the "animal spirit," or pneuma, and thence carried by the nerves which were thought to be hollow to endow the body with higher nervous function. He believed that disease was chiefly caused by an excess of blood, a theory which backed the popular practice of blood-letting.

130-200 A. D.—Galen added to the ideas of Erisistratus his theories that blood in the liver was endowed with natural spirit, whence it ebbed to and fro in the veins to provide the body with growth and nutrition; impurities were carried to the lungs by the vena arterialis and exhaled; part of the venous blood passed through invisible pores in the muscular septum of the heart from right to left ventricle where, mixed with air drawn from the lungs by the arteria venalis, it became of higher grade, supplied with the principle of life and charged with the vital spirit, to ebb to and fro in the arteries, endowing the body with function.

13th cent. A. D.—An-Nafis, an Arabian physician, was the only shining light of the Middle Ages. He described pulmonary circulation much as we understand it today, but his work has only recently been discovered, and hence had little influence upon historical development. He disagreed with many of the galenic views of circulation.

1452-1519—Leonardo da Vinci made many significant drawings of the heart and blood vessels. He showed that the air tubes in the lungs did not extend to the heart, but ended blindly. He established on a more accurate basis valve function and blood flow, and doubted Galen's septum theory.

1514-1564—Vesalius in his *Fabrica* stated that he doubted many

of Galen's tenets about the circulatory system, but he was unable to break completely from the tradition.

1511-1553—Servetus had a proper conception of the pulmonary circulation, and had some recognition that blood passed from arteries to veins in other parts of the body.

1537-1619—Fabricius, Harvey's teacher at Padua, contributed several interesting anatomical observations.

1628—William Harvey published his "De Motu Cordis," child of experimentation and mathematical logic born to rouse a Galenic world and a static science, lain dormant for over fourteen hundred years, to dynamics and modern physiology. A pioneer in quantitative methods, Harvey calls on them to blow the dust of tradition to the four winds. " . . . the left ventricle of the heart when filled in diastole, contains two or three ounces. In a cadaver I have found it holding more than three ounces." Thus he starts his quantitive proof of circulation, arriving at the logical conclusion that if the blood pumped from ventricle to arteries did not return to the heart by the veins to be used again, its mass in the body in twenty-four hours would exceed the total body weight of six men. He could not see the capillary anastomoses which bridged the gap in the tissues between arteries and veins because he had no microscope, but he could see by the valve arrangement that blood could flow in only one direction, so he refuted the traditionalists and die-hards conclusively with what evidence he had.

Specifically Harvey's outstanding contributions to our knowledge of the vascular system are as follows: He gave us the correct interpretation of the heart's diastole and systole. He showed the manner and direction of contraction of the heart muscle fibers. He correlated artery pulsation with heart beat. He made a very beautiful demonstration of the origin and conduction of the heart beat. The list is too long to go on, but suffice it to say that the characteristics of the work of this great man are his keen observation, his quantitative approach, clear reasoning power, and his scientific intolerance of mere verbal logic unsubstantiated by experiment.

Harvey left little in a general way to be discovered about the mechanics of circulation. Marcello Malpighi, soon to follow, filled the breach with his observations through the microscope of the liv-

ing frog's lung. In that delicate tissue he saw the capillaries through which blood flowed from arteries to veins. The picture was complete. The endless circuit of blood was definitely established now for good and all.

We regret that this paper has been of necessity so short, and we leave it with a feeling of having slighted the work of these great men who elucidated for us and for the world this problem of the circulation of the blood, so complex, and so important to man.

ALLEN M. FERRY,
STEWART GEO. WOLF, JR.

THE HISTORY OF THE ANATOMY AND PHYSIOLOGY OF RESPIRATION

PART I

My partner, Mr. Chatard, and I collaborated in the preparation of this paper which attempts to present, from the historical point of view, the concepts and discoveries which led to our present-day understanding of the anatomy and physiology of respiration. A discussion of this subject lends itself naturally to a division of two broad periods; the first, including the development of respiratory concepts from the days of early Greece to the Renaissance; and the second period, from the Renaissance to modern times. Part One discusses the first and comparatively unimportant period, which really serves as a sort of prologue to the important second.

The rhythmic respiratory movements of the body naturally struck the observations of the ancients so they attempted to explain this phenomenon, and since they were more interested in the *reason* than the *cause*, much of the earlier work concerned itself with the study of the air that enters and leaves the lungs with each respiration. Hippocrates of Cos (about 400 B. C.) wrote a sophistic essay on "Breaths" in which he pointed out the universal necessity of air as an introduction to his thesis that "diseases are all the offspring of air." "What," Hippocrates asks, "can take place without it? In what is it not present? What does it not accompany? For every-

thing between heaven and earth is full of wind . . . the progress of the sun, moon, and stars is because of wind; for wind is food for fire, and without air fire could not live. . . . Nay, it is clear, too, that the sea partakes of wind, for swimming creatures would not be able to live did they not partake of wind. Now how could they partake except by inhaling the air of the water?"

Aristotle, (384-322 B. C.) who was weaker in physiology than morphology, wrote a lengthy essay entitled "De Respiratione" in which he attempted to prove that the respiratory tract is essentially a refrigeration unit. "The universal cause of the need which the animal has for refrigeration, is the union of the soul with fire that takes place in the heart."

Erasistratus, the "Father of Physiology," developed the theory that air passes from the lungs to the heart, where it becomes transformed into a peculiar pneuma, the *vital spirit,* which is sent out to the various parts of the body through the arteries. When it reaches the brain it is further changed to a second kind of pneuma, the *animal spirit,* which in turn is conveyed to the different parts of the body by the nerves, which are hollow. It might be noted that Erasistratus was essentially a "rationalist," professing himself a foe of all mysticism.

Galen of Pergamum (A. D. 129-99), second only to Hippocrates as the greatest of ancient physicians, propounded a physiological system essentially the same as that just reviewed except that it was further complicated by a third, or *natural spirit.* This system dominated until Harvey's day, one thousand five hundred years later. This explanation, at first glance, appears aëry and fantastic to our modern eyes but it is more than likely that their system of coördinated and controlling *spirits* was their way of accounting for the effects we now know to be due to the respiratory center in the medulla. But here, as elsewhere, the modern stands amazed before the intellectual activity of the ancients. "Their imaginations, although unchecked and ill-disciplined, were alive and active. They loathed mystery; their curiosity remained unsatisfied until they had discovered a rational cause, even though that cause was grounded on insecure foundations."

"Galen's work," as Singer says, "makes the 'Indian Summer'

of the Anatomy and Physiology of antiquity; for on his death in 199 the active prosecution of anatomical and physiological investigation ceased absolutely." The curtain descends at once on Part One of this paper.

F. H. CONSTANTINE.

PART II

MODERN DEVELOPMENTS

It was not until the beginning of the Renaissance that definite progress was made in the development of the modern theory of respiration. From this time on many experiments were performed in this field from which definite conclusions could be drawn. The evidence of this new activity was first seen, as would logically be expected, in the field of anatomy, a field which was rapidly advancing with the impetus given it by Vesalius. So we find that Harvey, following the work of predecessors, in 1628 gives us an accurate description of the existence and function of the pulmonary circulation and then a few years later Malpighi, the brilliant founder of histology, describes and draws for us the capillaries and alveoli of the lungs and shows their close contact with each other.

At the same time we find the rise of the Iatro-physical school under the leadership of Giovanni Borelli. He presents us with our first real knowledge of the mechanical features involved in the process of breathing. His theories in this regard were quite adequate for the time and show a very clear understanding of the movements of the chest. About the same time Boyle in England was experimenting on animals with the recently developed pneumatic pump. By his experiments Boyle showed that a vacuum would cause an animal to die quite the same as it would extinguish a flame. And so he concluded that combustion was similar to life in that both required air.

Hooke and Lower next interested themselves in this subject. They performed experiments with artificial respiration on dogs which had had their lungs exposed. Their experiments showed that the heaving of the chest was not necessary for life but merely to

draw fresh air into the lungs. They also showed that the air was absorbed by the blood, this being the essential part of respiration.

John Mayow offered the next contribution to the subject by applying his chemical theories to respiration. He had developed a theory of combustion in which he recognized the existence of what he called nitro-aereal particles and what is now known as oxygen. This substance he said was a part of the air, was in fact that part of the air that was absorbed by the blood through the lung tissue. He wrote a treatise on respiration in which he presented not only his theory of the chemistry of respiration but also a very clear description of the anatomy and physical principles involved in breathing. Indeed he did very comprehensive work in this field.

Joseph Black a century later went further through his discovery of carbon dioxide and his study of its properties. He showed by experiment that it would not support animal life and on the other hand that it was produced by the body and expelled through the lung. While he was doing this work Albert Haller was performing many of his experiments, quite a number of which concerned the subject of respiration. One of his main contributions was the proof of the impermeability of the pleura to air with the resulting conclusion that the lungs must expand when the thorax expands.

It remained for Priestley or really Lavoisier to isolate oxygen and study its properties, for this Mayow had been unable to do. Lavoisier showed that it was oxygen that was used in animal combustion uniting with the carbon of the body to form the fixed air that Black had discovered. Lavoisier did think, however, that carbon dioxide was formed in the lung rather than in the tissues. Besides this Lavoisier made the first experiment in the field of basal metabolism when he collected and measured the carbon dioxide expired by man. The work of these men had developed the theory of respiration into a very complete system, in fact it had correlated the various processes into an essential scheme to which the finer details of the more modern workers could be easily added.

FERDINAND E. CHATARD IV.

RESPIRATION AND CIRCULATION OF THE BLOOD

Wall Exhibit

PLATE V

HIPPOCRATES

A portrait.

DIAGRAM OF THE ANATOMY OF THE CIRCULATORY SYSTEM ACCORDING TO DIOGENES

A pre-Aristotelian system.

DIAGRAM OF THE ANATOMY OF THE CIRCULATORY SYSTEM ACCORDING TO POLYBUS

A pre-Aristotelian system.

DIAGRAM OF THE ANATOMY OF THE CIRCULATORY SYSTEM ACCORDING TO ARISTOTLE, 384-322 B. C.

The three preceding diagrams were taken from Aubert und Wimmer, *Aristoteles Thierkunde*, Leipzig, 1868, Pls. 4-6.

DIAGRAM REPRODUCING GALEN'S IDEAS ON THE DISTRIBUTION OF THE BLOOD

For explanation, see preceding text, by A. M. Ferry and S. G. Wolf, Jr. (After Charles Singer, *Discovery of the circulation of the blood*, London, 1922.)

ROBERT BOYLE (1626-1692)

The philosophical works of the Hon. Robert Boyle, Esq., by Peter Shaw, London, 1725, Vol. II, Pl. VIII. A plate illustrating Boyle's experiment to determine the effect of a vacuum on a living animal. In conjunction with this, he made a thorough study of the weight and pressure of the atmosphere.

JOHN MAYOW (1643-1679)

Tractatus quinque medico-physici, Oxonii, 1674. An illustration of Mayow's experiment on the absorption of air by living animals, showing that there was a definite constituent of the air necessary to life.

WILLIAM HARVEY (1578-1657)

A portrait.

JOHN MAYOW (1643-1679)

Tractatus quinque medico-physici, Oxonii, 1674. Drawings illustrating Mayow's description of the thorax, the intercostal muscles, and the relative pressure in the lungs and pleural cavity—the mechanics of respiration.

A drawing of Lavoisier in his laboratory conducting an experiment in "rebreathing" in order to ascertain the element necessary to life. From a drawing by Mme. Lavoisier. In: Gabriel Hanotaux, *Histoire de la Nation Française*, Paris, Librairie Plon, 1924, vol. XIV, p. 432.

GIOVANNI ALPHONSO BORELLI (1608-1679)

De motu animalium, Rome, 1681. A plate showing a dissection of the heart, and the physiological properties and functions of the heart muscles. Borelli, primarily trained as a mathematician and physicist, saw the application of these to the rising sciences of anatomy and physiology. He felt himself able to explain all the physiological phenomena on a mechanical basis—digestion, circulation, respiration, and all their relative activities.

A SCHEME OF THE CIRCULATION OF THE BLOOD ACCORDING TO HARVEY

Schematic representation of the modern conception of the circulation and distribution of the blood. (After Charles Singer, *Discovery of the Circulation of the Blood*, London, 1922.)

JOSEPH PRIESTLY (1733-1804)

Experiments and observations relating to various branches of philosophy . . . Birmingham, 1781. An experiment showing that plants restore oxygen, then unknown as such, to expired air. Priestley's deplored phlogiston theory was actually just an involved way of trying to get at the mysterious constituent of air which supported life and combustion. Lavoisier, who gave the element its name and outlined its properties, repudiated this theory which he considered a hopeless deviation from the proper path, but which was really the background for his own experimental work.

CASE V

LEONARDO DA VINCI (1452-1519)

Quaderni d'anatomia . . . Christiana, 1911. Sketch of the arrangement of the ribs and intercostal muscles.

WILLIAM HARVEY (1578-1657)

Exercitatio anatomica de motu cordis et sanguinis in animalibus, Francofurti, sumptibus Guilielmi Fitzeri, 1628. First edition of the epoch-making treatise on the circulation of the blood.

JAN SWAMMERDAM (1637-1680)

Title-page of *Tractatus physico-anatomico-medicus de respiratione usuque pulmonum*, Lugduni Batavorum, 1667. From: *Opuscula selecta Neerlandicorum de arte medica*, Amsterdam, 1927. Swammerdam, an avid naturalist, was nevertheless curious along physiological lines, and perfected a simple plethysmographic method of studying the respiratory

movements of the chest wall that far antedated the work of Blasius and others.

RICHARD LOWER (1636-1691)

A diagram of the venous valves, from *Tractatus de corde item de motu et colore sanguinis*, Amstelodami, Daniel Elzevir, 1669.

JOHN MAYOW (1643-1679)

Tractatus de respiratione, in: *Tractatus quinque medico-physici*, Oxonii, 1674.

MARCELLO MALPIGHI (1628-1694)

De pulmonibus epistolae II, in: *Opera omnia*, London, 1686. A discussion of the structure and function of the lungs in two letters written to Borelli, in which the existence of capillary anastomosis was first set down.

Two diagrams, one of a frog's lungs in cross-section, one in long. Malpighi completed Harvey's hypothesis by the use of a microscope, though it is problematical whether or not he actually saw the blood-cells passing through the capillaries.

ROBERT BOYLE (1626-1692)

The philosophical works of the Hon. Robert Boyle, Esq., by Peter Shaw, London, 1725.

ALBRECHT VON HALLER (1708-1777)

Deux mémoires sur le mouvement du sang . . . Lausanne, Bousquet et comp., 1756. An important contribution to the physiology of the blood.

JOSEPH PRIESTLEY (1733-1804)

Experiments and observations relating to various branches of philosophy . . . Birmingham, 1781.

Traité de la structure du coeur et de ses maladies, by M. de Senac, Paris, Méquignon, 1783.

CASE VI

HISTORY OF PHYSIOLOGICAL TEXT BOOKS

THE EBERS PAPYRUS (c. 1500 B. C.)

An English translation by Cyril P. Bryan, London, 1930. Chapter XX, on the Heart and Circulatory System.

PLATO

Timaeus, in: Loeb Classical Series, Plato, vol. 7, translated by R. G. Bury, London, 1929.

ARISTOTLE

De partibus animalium, in: Works of Aristotle, Oxford, 1911.

PLATE VI

HIPPOCRATES

De la nature de l'homme, in: Emile Littré, Oeuvres d'Hippocrate, Paris, 1851, vol. 6.

GALEN

On the use of the parts of the human body. Edited by G. Helmreich, Leipzig, 1907.

Nemesii episcopi Premnon Physicon . . . a N. Alfano archiepiscopo Salerni . . . in Latinum translatus recognovit Carolus Burkhard, Lipsiae, 1917.

AVICENNA (980-1037)

A treatise on the Canon of Medicine of Avicenna, O. Cameron Gruner, London, 1930. A chart showing correlation of faculties with bodily organs.

JEAN FERNEL

De partium corporis humani descriptione, Physiologiae libri VII, in: Universa medicina libris absoluta, Lutetiae Parisiorum, apud Andream Wechelum, 1567.

ALBRECHT VON HALLER (1708-1777)

A portrait, from an engraving by I. I. Haid, in: *Die Bildnisse Albrecht von Hallers*, von Dr. Arthur Weese, Bern, 1909.

Primae lineae physiologiae, Göttingen, 1747.

Primae lineae physiologiae, Venetiis, 1754.

Primae lineae physiologiae, . . . auctae ab Henrico Augusto Wrisberg, Goettingae, 1780.

First lines of physiology, Edinburgh, 1801.

Elementae physiologiae corporis humani . . . Lausanne, 1757-1766, 8 vols.

Dr. Albert Haller's physiology . . . in 2 volumes, London, 1754.

De partium corporis humani praecipuarum fabrica et functionibus, Bernae, 1777.

Albrecht von Hallers Briefe an Johannes Gesner, 1728-1777, hrsg. von Henry E. Sigerist, Berlin, 1923.

Portrait of Hermann Boerhaave.

Hermann Boerhaave's *Praelectiones academicae . . . edidit Albertus Haller*, Göttingen, 1740. *Actio intestinorum in ingesta*, vol. I.

There are more than twenty-five editions of Haller's *Primae lineae physiologiae*, published between 1747 and 1812. Its use as a textbook for students from Göttingen to Edinburgh was unlimited. But, anxious to survey the entire problem of physiology, historically, critically, experimentally, and finally, to attach physiology to growing pathological conceptions, he published, in the years 1757 to 1760, the gigantic

Elementae physiologiae, which escorted physiology throughout medical history and through the hands of all the masters, to his own experiments.

Jo. Frid. Blumenbach (1752-1840)

Institutiones physiologicae, Gottingae, 1787.

Francois Magendie (1783-1855)

An elementary summary of physiology, translated from the French by J. S. Forsyth, London, 1825.

Johannes Mueller (1801-1858)

Handbuch der Physiologie des Menschen für Vorlesungen, Coblenz, 1840.

Daniel Oliver

First lines of physiology, Philadelphia, 1841.

Rudolph Wagner

Handwörterbuch der Physiologie mit Rücksicht auf physiologische Pathologie, Braunschweig, 1842.

Lois physiologiques, par B. Mojon . . . traduites de l'Italien avec notes par J. B. Michel, à Gênes, [n. d.]

William B. Carpenter

Elements of physiology, including physiological anatomy, for the medical student, Philadelphia, 1846.

Alexander Ecker

Erläuterungstafeln zur Physiologie und Entwicklungsgeschichte, in: Icones Physiologiae, Leipzig, 1851-1859.

Ernest H. Starling

Principles of human physiology, London, 1926.

Historical

Jules Soury, *Le système nerveux central, structure et fonctions* . . . Paris, 1899.

Michael Foster, *Lectures on the history of physiology*, Cambridge University Press, 1901.

William Stirling, *Some apostles of physiology*, London, 1902.

Charles Singer, *The discovery of the circulation of the blood*, London, 1922.

John F. Fulton, *Physiology*, in: Clio Medica, New York, 1931.

K. Hintze, *Geographie und Geschichte der Ernährung*, Leipzig, 1934.

Joseph Needham, *A history of embryology*, Cambridge Univ. Press, 1934.

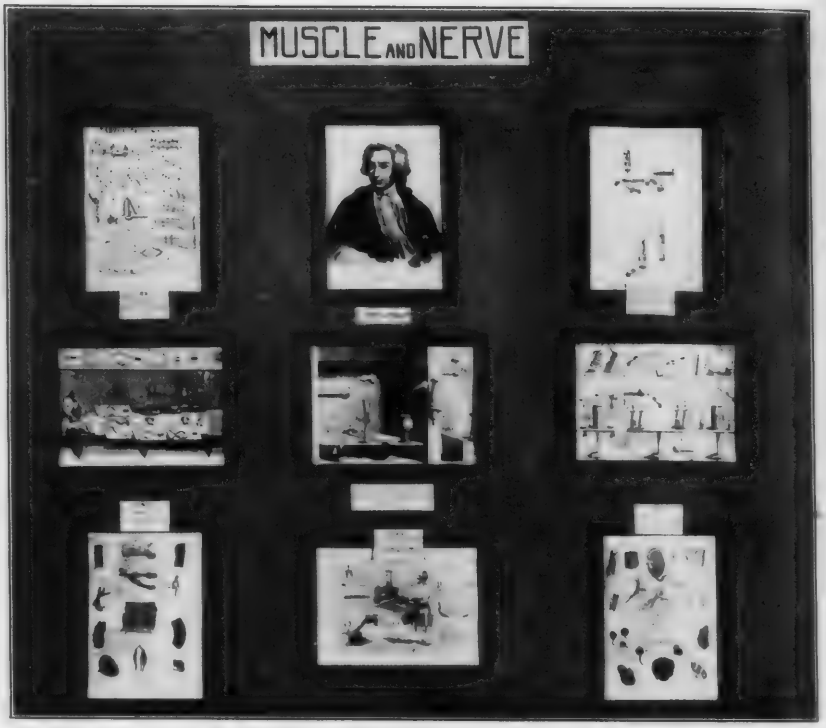


PLATE VII

MUSCLE AND NERVE

The Ancients had only vague notions about the relationships of Nerve and Muscle. We know that Aristotle (4 cent. B. C.), called tendons and nerves by one and the same word, Neuron, and that later The Alexandrians, Herophilus (about 300 B. C.) and Erasistratus (about 260 B. C.), distinguished between nerves and tendons, and recognized that there were two kinds of nerves, sensory and motor. However, our real starting point in this discussion is with the knowledge of Galen (129—about 199), the last of the great ancient physicians, since his work represents the best views of the ancients and the middle ages.

Galen's work on the muscular system was really pioneer in character. He wrote a special book, " On the Anatomy of the Muscle "; " Throughout his works, the muscles are perhaps the structures that he described most accurately. Galen described about 300 muscles and several of the names that we now use are derived from him, among them the masseter and cremaster. For his investigation of muscles, Galen used particularly the Barbary Ape " (Singer).

He classified two parts of muscle, (1) *Tendinous fibers,* (2) *Fleshy substance* (piled round about). He claims that the contractile power of the muscle lies in the fibers of the muscle and not in the fleshy part. His theory of innervation is that Vital Spirits go to the brain from the heart and are there transformed into Animal Spirits which then come from the brain, travel along the nerves and entering the fibers of the muscle, cause the muscle to swell transversely and to shorten longitudinally, thus giving motion to the muscle. This theory assumes an increase of volume in the muscle during contraction. The Galenic theory had a profound influence on the study of muscle and nerve, down through the ages.

Leonardo da Vinci (1452-1519) applying his skill of an artist and an engineer made a geometrical analysis of muscular action. However, his physiology of muscular action was that of Galen. Leonardo's work received very little attention at his time, mainly from the fact that it was never published, and remained buried until late in the 18th century.

Thus the knowledge of muscle and nerve remained more or less static until the coming of the famous Andreas Vesalius (1514-1564). As Foster puts it, " Vesalius opened up the way for physiological inquiry by his exact anatomical labours, but he left the physiological plough almost as soon as he had put his hand to it." He saw clearly that the contractile power of the muscle resides in the actual muscular substance and not in the fibers. Here we see a contradiction of Galen, but then Vesalius still held to the Galenic theory of Animal Spirits.

After Vesalius, Fabricius (1537-1619) and Descartes (1596-1650), worked on the subject but added very little of note.

After Descartes, we see a whole group of men, who seem to be " just hovering about the truth," (Foster), their arrows never hitting the vital spot. This group consisted of Croone, (1633-1684), Willis (1597-1677), Mayow (1643-1679), Stensen (1638-1686), Glisson (1597-1677), Swammerdam (1637-1680). Of these men, Glisson and Swammerdam came closest to the truth. Glisson anticipated modern teaching by 100 years, by introducing us to " irritability," (1662) which he claimed was a specific property of all human tissues. His idea was fundamental and highly philosophic, and thus it probably did not meet with immediate recognition. Haller made it narrower and was understood a century later. With Glisson we also see the breaking away from the Galenic theory by his proving that the volume of a muscle did not increase during contraction. Jan Swammerdam, the gifted naturalist of Holland, experimented quite a bit on the muscles of frogs, beginning at the age of 21, and had actually at that age made the discovery of animal electricity; he evidently did not realize what he had, and it was not until 1738, which was 58 years after his death, that his work was brought out by his fellow countryman, Boerhaave. Swammerdam also performed experiments to show that muscle volume did not increase in contraction.

We now come to the Italian, Borelli (1608-1679), a pupil of Galileo, who brought to the study of the action of muscles a profound knowledge of physics and mathematics and really founded the mechanical or iatro-mechanical school. As Osler puts it, " The literature and the language of medicine became that of physics and

mechanics; wheels, pulleys, wedges, levers, screws, cords, canals, angles, cylinders, resistance and etc., came into medical literature." His work on movement in animals was published after his death in 1680, although he had lectured on it years before (1662). Borelli treated both external and internal movements and his discussions concerning the special problems of external motion may be read with profit, even today, as they supply the "basis of muscular mechanics" (Foster). His view of nervous action was entirely a physical one, as he considered nerves like canals filled with a spongy material like elder pith, which might transmit any commotion or concussion, caused by nervous fluid from one end to the other. This transmission caused the ejection of some droplets of the nervous fluid into the substance of the muscle, and thus gave rise to contraction. This contraction, he regarded as chemical in nature, but he spoke very guardedly on this. Thus, it can be seen, that with Borelli, we have a new era in the development of muscle and nerve physiology.

To Robert Whytt (1714-1766), we owe the summation of the theories of innervation up to and including his time. In concluding this summation he says, "'Animal spirits' is merely a term and can be used to express the existence of such a power even though its actual nature is unknown as, Newton did with gravitation." Here we see a definite break with the Galenic theory.

And now we come to Albrecht von Haller (1708-1777), the famed poet, naturalist, and as Garrison calls him "The master physiologist of his time." Haller bases his work on experiments, in fact 567, of which, he himself performed 190. "Irritability" has already been mentioned in connection with Glisson (1662), Haller now goes to work on this with gusto. Defining "Irritable," and "Sensible," and distinguishing between them, he classifies parts of the body under either one or the other headings. He found that the most irritable parts are not at all sensible, and vice-versa, the most sensible are not irritable. Haller's work added measurably to the true conception of the relationship between muscle and nerve.

We now enter upon an entirely different period. The period of the Introduction of the Electrical Concept. To Luigi Galvani (1737-1798) we owe the beginning of this period. Evidently influenced

by Franklin, he began experimenting with the electrical activity of frog's legs, and it was he who coined the term "Animal Electricity." His experiments begun in the 1770's and results published in 1791 brought about a veritable storm of controversy. His idea was: If a metallic arc, constructed of two metals, was placed in contact, the one with a frog's nerve and the other with a muscle, it caused the contraction of the latter. Galvani attributed this to "Animal Electricity." Volta (1745-1827), one of Galvani's contemporaries disagreed with this theory and claimed that the effect was due to electricity having its source in the junction of two dissimilar metals of the arc and regarded the nerve and muscle, simply as conductors. "We have here an example of two supremely important discoveries which arose from a controversy. It is now evident that both assertions were correct, both denials incorrect. Animal currents exist, metal currents exist; the latter in Volta's hands were the seed out of which have sprung the battery, the telegraph, the electric motor, the electric light, and the telephone; the former in Galvani's hands is the parent of the more hidden offspring, animal electricty, or the electricity evolved by living tissues" (Fulton).

Galvani proved his theory by a second experiment in 1793, and the results were published in 1794, in an anonymous tract, "Dell' uso e dell' attivita dell' arco condutore nelle contrazioni dei muscoli." This showed that there was a difference of potential set up between the injured and the uninjured tissue.

These discoveries of Galvani and Volta opened up the field and much work was done in the next few years. Matteucci (1811-1868), Du Bois Reymond (1818-1896), Helmholtz (1821-1894), Pflüger (1829-1910), Ludwig (1816-1895), Bowditch (1840-1911), all contributed greatly to the subject.

Matteucci, following up Galvani's experiments with injured tissue, and Du Bois Reymond also working on this, brought forth the discovery of the negative variation or "action current." Du Bois Reymond, "the greatest name in the early history of electrophysiology," (Fulton), introduced the Faradic stimulation by means of the induction coil, worked on Tetanus, was the first to describe Electrotonus, in fact he wrote volumes on the electrophysiology of nerve and muscle—much of which we still use today. "It will suf-

fice to say that he was a man of wide interests and broad philosophical outlook," (Fulton). Then Helmholtz measured the velocity of conduction along a nerve, and we know Pflüger, by his "Law," and Ludwig for his famous laboratory where he trained so many physiologists, and Bowditch, a product of this laboratory, famous for his "All or None Theory." The work of these men brings us into the realm of the present.

The growth of the knowledge concerning Muscle and Nerve is a fascinating and striking example of the bloom of Truth, the petals gradually unfolding.

M. L. SINGEWALD.

MUSCLE AND NERVE

Wall Exhibit

PLATE VII

JAN SWAMMERDAM (1637-1680)

An experiment on volume changes in muscle during contraction. He conclusively proved that no such alteration took place. From his *Biblia Naturae*, 1737-1738.

GIOVANNI ALPHONSO BORELLI (1608-1679)

De motu animalium, Rome, Angelo Bernabo, 1681. Mechanical representations of muscle action.

ALOISIO GALVANI (1737-1798)

A portrait.

De viribus electricitatis in motu musculari, Mutinae, 1792. Three plates showing the reaction of the nerves and muscles of a frog to various stimuli (touch, electricity).

EMIL DU BOIS-REYMOND (1818-1896)

Untersuchungen über thierische Electricität, Berlin, G. Reimer, 1848. A plate illustrating experiments on the reactions of frog muscles to electrical stimulation. Though du Bois-Reymond, a pupil of Johannes Müller, confined his research almost exclusively to the solving of problems in the physiology of muscles and nerves, his laboratory technique and electrical apparatus remained for a long time the standard experimental outfit in a physiological laboratory. He widened considerably the scope of such experiment, as well as the knowledge of muscles and nerves.

ALEXANDER ECKER

Histology of the muscles
Histology of the nerves
} *Erläuterungstafeln zur Physiologie und Entwicklungsgeschichte,* in: Icones Physiologiae, Leipzig, 1851-1859.

CASE VII

GALENI DE MOTU MUSCULORUM

Volume IV of Galen's works, edited by Carolus Gottlob Kühn, Leipzig, 1822.

APOLLONIUS OF KITIUM

Illustrierter Kommentar zu der Hippokratischen Schrift . . . by Hermann Schöne, Leipzig, 1896. An illustration from the text of Apollonius of Kitium in a 9th century Byzantine manuscript, showing muscular development in the male figure.

LEONARDO DA VINCI (1452-1519)

Quaderni d'anatomia . . . Christiana, 1911, vol. V. Experiments with muscle action, using strings as muscles.

NICOLAUS STENSEN (1638-1686)

Elementorum myologiae specimen, seu musculi descriptio geometrica, Florentiae, sub signo Stellae, 1667. Plates II and III, showing schematic drawing of muscle fibres.

GIOVANNI ALPHONSO BORELLI (1608-1679)

De motu animalium, Rome, Angelo Bernabo, 1681. All things in motion captivated the experimental instincts of Borelli—the contraction of a bird's gizzard, the leverage in a man's arm, the contraction and expansion of the heart muscles. He was a sound physiologist, and a confirmed mechanist in his explanations of physiological phenomena, though he clung to ancient concepts when it came to chemistry and the analysis of content and quality.

Dell' elettricisimo, o sia delle forze elettriche de' corpi . . . Venezia, Gio. Battista Recurti, 1746.

ALBRECHT VON HALLER (1708-1777)

A dissertation on the sensible and irritable parts of animals . . . trans. by M. Tissot, London, 1755. Haller's observations made clear to him the distinction between sensibility and irritability in animal organs. It was his chief contribution to the advance of physiology, and a definite turn in the direction of vitalism.

GIORGIO BAGLIVI (1668-1707)

Opera omnia medico-practica et anatomica, Norimbergae, Jo. Adam

Stein et Nic. Raspe, 1751. *De fibra motrice et morbosa.* Baglivi was an iatromechanist in theory, and an absolutely untraditional practitioner. Being a university professor, his practice did not creep into his teachings, and it remained for the clinicians to bring about the break away from iatromechanism, rather than the university and research factions.

EMIL DU BOIS-REYMOND (1818-1896)

A portrait.

Untersuchungen über thierische Electricität, Berlin, G. Reimer, 1848.

EDUARD PFLUEGER

Untersuchungen über die Physiologie des Electrotonus, Berlin, August Hirschwald, 1859.

THE HISTORY OF THE HIGHER NERVOUS FUNCTIONS

Real progress in the knowledge of higher nervous function may be said to begin with the Greek physician Galen. Most of the work before his time is poorly preserved, and since it was Galen who first set down for posterity a systematic picture of the nervous system and its function, we may trace the history of this field from these crude, second century beginnings.

Galen had a remarkable knowledge of the anatomy of the mammalian brain. When one reads some of his work, it is quite easy to see why he was considered the authority in this field over that long period where experimentation and observation were so seldom employed. His idea of the function of the nervous system is, of course, much less reliable than his knowledge of its anatomy. He ascribed to what he called nerves both a vital and a mechanical function. While his concept of the sensory function of the nerves seems quite correct, his theory of motor function is more closely applicable to tendons. He divided the brain into a soft, anterior, sensory portion and a hard, posterior, motor portion. His theory of brain function was one of dynamism with its activities centered about the four ventricles. These ventricles, to each of which he assigned a particular mental function, were focal points for a continuous shift and interplay of the very brain matter itself.

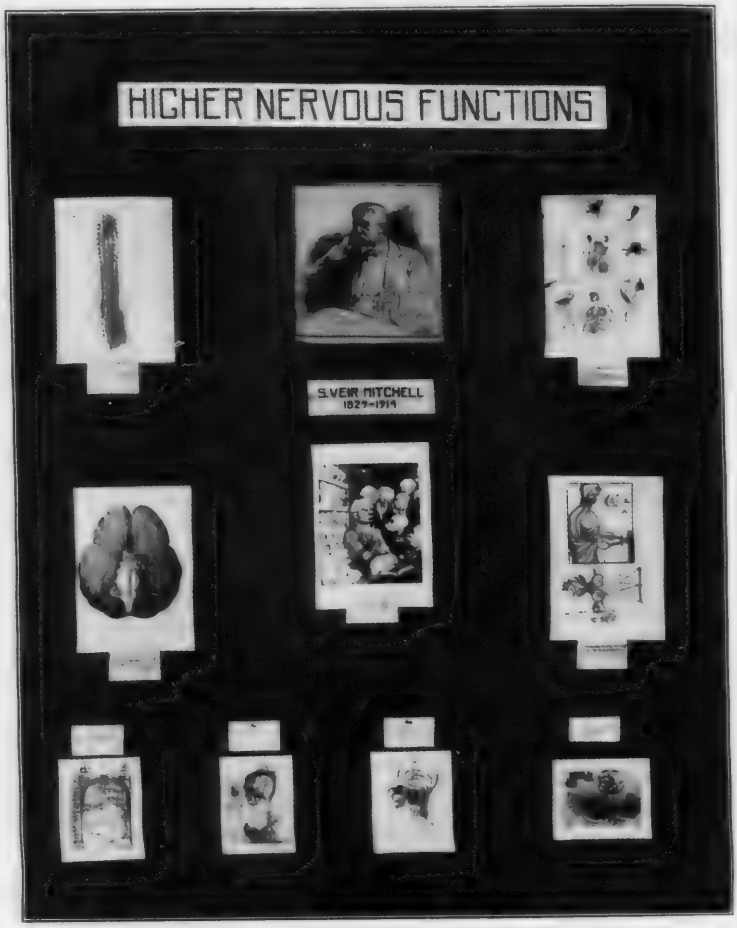


PLATE VIII

Following his work no constructive advance was made until the time of Vesalius. During the interim of some 13 hundred years the Galenic tradition was carried on by the Arabian physicians. Chief among these was Avicenna, in whose speculations on the brain we see an exact reproduction of the original observations of Galen.

The fifteenth century brought a striking advance with the accurate and fearless thinking of Leonardo da Vinci. Unfortunately, the clear-cut anatomical findings and magnificent drawings of this versatile Italian remained practically unnoticed until the eighteenth century, so that their true influence on progress in Leonardo's time was negligible.

The first real break with Galenic authority and tradition was due to Andreas Vesalius. This meticulous and indefatigable worker initiated the scientific approach to anatomical problems, and recorded his work through the gifted brush of Stephan van Kalkar. Chief among his numerous experimental ventures was that in which he traced the distribution of nerves by the ligation method which is still employed today.

One hundred years after Vesalius we find an attempt on the part of such men as Van Helmont and Descartes to place higher nervous functions on a purely rational rather than experimental basis. True, they did make observations on the brain and nervous system, but their schemes were purely meditative attempts at a synthesis of the functions. In the line of actual experimental activity they made little progress. In fairness to Descartes, however, his many striking advances in physiology must be recognized, a characteristic one being his original explanation of the fact that one blinks his eyes if a blow be aimed at them. His well-known assumption of the pineal gland as the seat of the soul is supported by such a wealth of persuasive reasoning that one almost excuses his pitifully inadequate physiological foundation for this schema.

Returning to the experimental school we have the observations of such histologists as Marcello Malpighi. This painstaking microscopist made brilliant observations on the minute anatomy of the nervous system but paid little attention to its function.

Though the gross anatomists of this time spent considerable

effort on the physiological interpretation of their results, their digressions into this field led them into serious error. Most outstanding of these gross anatomists was Thomas Willis. His account of the anatomy of the nervous system was far and away the most accurate treatise on the subject up till about the time of modern medicine. Unfortunately he muddied the waters of this lucid discussion by introducing the customary mass of unsubstantiated theories regarding the physiology of this region. As a result, he is often harshly criticized as a mere mimic of Descartes, or as a trader on the valuable contributions of his associates, Richard Lower and Sir Christopher Wren. It was Willis' large practice which kept him from his laboratory the greater part of the time, making understandable how his chief activity came to be speculation in preference to research. His impression on medicine and its terminology is none the less deep and lasting, and his personal work has made itself felt in the fields of epidemic diseases, otology, and even pharmacology.

In the anatomical progress of the seventeenth century, mathematicians played a prominent role. The outstanding contributor among these investigators was Giovanni Borelli, the originator of the neurogenic theory of heart action.

Just after this period of anatomical investigation begun by Vesalius, during which so much new knowledge of anatomy and physiology was being acquired, Albrecht Von Haller compiled the first great synthesis of this knowledge since that of Galen. Still later, Gall and his ideas of phrenology became fashionable. He believed that one's mental development, as evidenced by increased size of the various regions of the brain, could be read by the bumps on the exterior of the skull.

Sir Charles Bell and Marshall Hall are representatives of the next period in these developments, extending from the late eighteenth to the middle of the nineteenth century. This was the period of transition into our modern period of experimental research. It was Bell and Hall who radically changed the neurological theories of their time, by dividing the higher nervous functions into virtually the same categories which obtain today. A talented and likable English surgeon, Sir Charles Bell accomplished a great service to humanity in eliminating the vicious surgical treatment of disorders of the facial

nerves by emphasizing their sensory and motor capacities. Marshall Hall demonstrated beyond all doubt the existence of the reflex nervous arc, enumerating for the first time the full complement of four types of nerve activity.

A generation later we find Weir Mitchell, the leading American neurologist of his time. In addition to clarifying the role of the cerebellum in the neural economy, Mitchell's work had great influence in establishing rules of research such as those which govern present investigators. Perhaps his best known accomplishment was the introduction of the "rest cure," which still persists today practically in the original form. Lack of space precludes mention of such brilliant nineteenth century workers as Bernard, Broca, Hitzig, Goltz, and Charcot.

Finally the work of Ivan Petrovitch Pavloff deserves mention. Pavloff was born in the middle of the past century, but his work has continued up to the present day. His chief efforts were directed toward the correlation of secretion and neural activity. The manner in which his pupils have carried on his work is typical of developments in the present century.

C. Rollins Hanlon,
J. Elliot Levi.

HIGHER NERVOUS FUNCTIONS

Wall Exhibit

Plate VIII

Magnus Hundt (-1519)

Antropologium de hominis dignitate, natura, et proprietatibus . . . 1501. A diagrammatic sketch of the still-prevailing mediaeval conception of the ventricles of the brain.

Leonardo da Vinci (1452-1519)

Quaderni d'anatomia . . . Christiana, 1911. Leonardo's interpretation of the classical conception of the brain ventricles.

Two pictures illustrating the topography of the brain as Leonardo actually observed it.

René Descartes (1596-1650)

Oeuvres de Descartes . . . Paris, Léopold Cerf, 1909, vol. XI, fig. 34.

An illustration of Descartes' conception of the centralization of sensations in the pineal gland—in this case, concomitant sensations of sight and touch.

THOMAS WILLIS (1621-1675)

Opera omnia, Amstelaedami, Henricus Wetstenius, 1682. *De cerebri anatome.* Drawings of the under surface of the brain, showing the arterial circle, and of the spinal cord. The originals of both drawings were done by Christopher Wren.

A caricature of Franz Joseph Gall, phrenologist, with his fellow-phrenologists.

ALEXANDER ECKER

Histology of the central nervous system. *Erlaüterungstafeln zur Physiologie und Entwicklungsgeschichte,* in: *Icones Physiologiae,* Leipzig, 1851-1859.

SILAS WEIR MITCHELL (1829-1914)

An original pencil portrait by George T. Tobin.

CASE VIII

Diagram of the centers of the brain, from a mediaeval manuscript.

Walter Sudhoff, *Die Lehre von den Hirnventrikeln in textlicher und graphischer Tradition des Altertums und Mittelalters,* Archiv für Geschichte der Medizin, Leipzig, 1914, vol. XVII, pp. 149-222.

AVICENNA (c. 980-1037)

Canon Medicinae . . . Venetiis, sumptibus Iuntarum, 1608.

ROBERT BURTON (1576-1639)

The anatomy of melancholy, London, 1676.

THOMAS WILLIS (1621-1675)

De cerebri anatome, in: *Opera omnia,* Amstelaedami, Henricus Wetstenius, 1682. Beyond his observation of the arterial circle now named for him, Willis contributed only vaguely to the knowledge of brain physiology.

CHARLES BELL (1774-1842)

The nervous system of the human body, London, 1830. Bell, who gave modern neurology its first forward push by his astute observations on the structure and function of the brain, established to a certain extent the rôles played by the various sections of the brain, a study that is increasing constantly the ability of the neurological surgeon to

tell by the flicker of an eyelid or the twitch of a facial muscle where to locate a growth in the brain.

MARSHALL HALL (1790-1857)

On the reflex function of the medulla oblongata and medulla spinalis, Philosophical transactions, 1832, pp. 635-665. A pioneer worker in reflex action.

JOHN CALL DALTON (1825-1889)

On the cerebellum as the center of co-ordination of voluntary movements (photostatic copy).

FRIEDRICH LEOPOLD GOLTZ (1832-1902)

Der Hund ohne Grosshirn (photostatic copy).

Crayon drawing by insane person, in: Hans Prinzhorn, *Bildnerei der Geisteskranken, ein Beitrag zur Physiologie und Psychopathologie der Gestaltung,* Berlin, 1923.

LIFE AND DEATH

Wall Exhibit

PLATE IX

A skeleton from a Roman mosaic.

In: Eugen Holländer, *Die Medizin in der klassischen Malerei,* Stuttgart, Ferdinand Enke, 1913.

An ancient mosaic with a skull. The original is in the Museo Nazionale, Naples.

In: Otto Brendel, *Untersuchungen zur Allegorie des Pompejanischen Totenkopf-Mosaics,* Mitteilungen des Deutschen Archäologischen Instituts, Römische Abteilung 49, 1934, pp. 157-179.

ST. HILDEGARD OF BINGEN

Illustration of a soul entering a human embryo, from the *Liber scivias* of St. Hildegard, Wiesbaden Codex B, fol. 22^{r}, c. 1150 A. D. From: Charles Singer, *Studies in the History and Method of Science,* Oxford, the Clarendon Press, 1917, vol. I, pl. XIX.

A symbolic representation of death, by Jean-Sebald Beham (1500-1550), an artist of the Renaissance. In: Otto Brendel: *Untersuchungen zur Allegorie des Pompejanischen Totenkopf-Mosaics,* Mitteilungen des Deutschen archäologischen Instituts, Römische Abteilung 49, 1934, pp. 157-179.

The Physician and Death.

A *totentanz* from a 16th century manuscript, in: Eugen Holländer, *Die Medizin in der klassischen Malerei,* Stuttgart, Ferdinand Enke, 1913.

PLATE IX

A lighted candle, symbolic of life. Johannes Beverovicius, *Allgemeine Artzney in dreyen Theilen verfasset . . .* Frankfurt am Mayn, 1674, p. 12.

Skeletons.

Andreas Vesalius, *De humani corporis fabrica libri V,* Basiliae, 1543. Artist, Stephan van Kalkar.

Bernardus Siegfriedus Albinus, *Tabulae skeleti et musculorum corporis humani,* 1747.
Artist, Jan Wandelaar.

CASE IX

Judgment scene from the Egyptian Book of the Dead.

From a papyrus in the British Museum. In: James H. Breasted, *The Dawn of Conscience,* New York, 1934, p. 256.

ARISTOTLE

De anima, in: *Works of Aristotle,* ed. by W. D. Ross, Oxford, 1931.

PLATO

Phaedrus, in: Loeb Classical Series, Plato, vol. I, ed. by Harold N. Fowler, London, 1928.

Ars moriendi, facsimile of a copy in the British Museum, published in London in 1881. Editio princeps, c. 1450.

The Bishop and the Squire. A *totentanz* by Guyot Marchand of Paris, 1485. In: J. Huizinga, *The Waning of the Middle Ages,* London, 1927, p. 130.

GOTTFRIED BIDLOO (1649-1713)

Anatomia humani corporis, centum et quinque tabulis per artificiosiss . . . Amstelodami, 1685. A skeleton, one of the plates drawn by Gerard de Lairesse (1640-1711) for Bidloo's book.

JOHANN CHRISTIAN REIL (1756-1813)

Von der Lebenskraft, 1803. In: Klassiker der Medizin, Leipzig, Barth, 1910. Reil was the first editor of the *Archiv für die Physiologie,* the first journal to be devoted to that science (Halle, 1795-1815). It later became *Müllers Archiv.*

XAVIER BICHAT (1771-1802)

Recherches sur la vie et la mort, Paris, 1800. Bichat was one of the chief links in the long chain of vitalism. For him, life had its laws in the phenomena of physiology, separate from the physical laws manifested by inert matter.

P. J. A. Lorenz

Essai sur la vie, Strasbourg, 1803.

An ancient depiction of Death, from *Lessings Werke*, hrsg. von Heinrich Kurz, Leipzig, vol. IV.

Otto Brendel

Untersuchungen zur Allegorie des Pompejanischen Totenkopf-Mosaics, in: Mitteilungen des Deutschen Archäologischen Instituts, Römische Abteilung 49, 1934, pp. 157-179.

Aldred Scott Warthin

The physician of the dance of death, New York, 1931.

MEDICO-HISTORICAL ACTIVITIES IN THE UNITED STATES

BALTIMORE, MARYLAND

JOHNS HOPKINS UNIVERSITY

Institute of the History of Medicine

COURSES FOR THE YEAR 1935-1936

HENRY E. SIGERIST, William H. Welch Professor of the History of Medicine and Director of the Institute of the History of Medicine.

OWSEI TEMKIN, Associate Professor of the History of Medicine.

JOHN RATHBONE OLIVER, Associate in the History of Medicine.

LUDWIG EDELSTEIN, Associate in the History of Medicine.

The Department is organized to afford opportunities for instruction, investigation and study in the history of medicine and kindred sciences.

During the academic year 1935-1936, the following elective courses will be offered:

INTRODUCTORY COURSES

1. An Introduction to the Profession of Medicine from the Standpoint of Ethics and History. Dr. OLIVER. Tu., 4-5, during the academic year, at Homewood. This course may be taken in two successive years.
2. Outlines of the History of Medicine. Dr. SIGERIST. First and second quarters, Tu., 4-5. An introductory course, illustrated by lantern slides, with bibliographic demonstrations, chiefly for first-year students.
3. History of Physiology and Pathology. Dr. TEMKIN. Third and fourth quarters, Tu., 4-5. A seminar course on the history of the main physiological problems, together with their anatomical and pathological aspects. Intended chiefly for first- and second-year students.

ADVANCED COURSES

4. Research Seminar. Dr. SIGERIST and Staff. First to third quarters, Th., 4-5. The recent literature dealing with the history of medicine from antiquity to the Renaissance will be reviewed, and the research problems involved will be discussed so as to give the students an opportunity to learn the research methods in medical history. Open to students of all classes.
5. Greek Medical Classics. Dr. EDELSTEIN. Second quarter, Fr., 4-5. A seminar course in which Greek medical books will be read and discussed. Knowledge of Greek is not required.

6. History of Clinical Diagnosis. Dr. TEMKIN. Third quarter, Fr., 4-5. A seminar course in which the history of various diagnostic methods will be studied by means of practical demonstrations. Intended for students from the second to the fourth year.

SOCIOLOGICAL COURSES

7. Social Aspects of Medicine. Dr. SIGERIST. Fourth quarter, M., 4-5. A course intended primarily for advanced medical students, in which the development of society and the medical profession in it will be studied. The course is intended to give the medical student a background necessary for the understanding of the modern social aspects of medicine.
8. Sociological Seminar. Dr. SIGERIST. Third and fourth quarters. A seminar course in which a definite set of problems will be studied. The course is open to 15 students, and will be organized in the beginning of the academic year so as to give the students enough time to prepare a paper.

The HIDEYO NOGUCHI LECTURES will be given in October, by Dr. Edward H. Hume on the subject of Chinese medicine.

The JOHNS HOPKINS MEDICAL HISTORY CLUB is closely connected with the Institute. Four meetings are held each year. Further information may be obtained from the Secretary, Dr. Oliver.

PUBLICATIONS OF THE INSTITUTE OF THE HISTORY OF MEDICINE, 1934-1935

Brooke, Helen C.; An exhibit illustrating the history of pathology. *Bulletin of the Institute of the History of Medicine*, 1934, vol. II, pp. 447-476.

——— A proposal for a free vaccine clinic in Baltimore in 1802. *Bulletin of the Institute of the History of Medicine*, 1935, vol. III, pp. 83-91.

——— A mediaeval poem on a gout remedy. *Bulletin of the Institute of the History of Medicine*, 1935, vol. III, pp. 163-164.

Edelstein, Ludwig; Methodiker. *Real-Encyclopaedie des Klassischen Altertums*, Suppl. VI, pp. 358-373.

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H. E. S.